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1957 - 1969

The JOURNAL OF THE MALACOLOGICAL SOCIETY AUSTRALIA is an annual publication for authoratative scientific p dealing with Mollusca and related topics.

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Mrs. D. I. HARTLEY

1957 - 1959

Miss F V. MURRAY

1960

Dr. D. F. McMICHAEL

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Mrs. D. I. Hartley
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1961-1966

Acceptance of papers for this Journal is in the hands of the Council of the Malacological Society of Australia. All enquiries and manuscripts should be forwarded to the Hon. Secretary, Malacological Society of Australia, C/o The Australian Museum, College Street, Sydney, N.S.W.

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NATIONAL MUSEUM OF VICTORIA

INTRODUCTION

The birth of the Journal of The Malacological Society of Australia is a welcome and significant milestone in the already rich history of Australian malacology. The marine fauna surrounding the continent is probably the most diverse and richest in the world, and for nearly 200 years its molluscs have attracted the attention of many well-known malacologists.

One hundred and eighty-seven years ago Dr. David Solander, a student of Linne's, stepped off Captain Cook's *Endeavour* and scoured the shores of Botany Bay in New South Wales. During the next hundred years, exploring expeditions from nearly every major power took back molluscan treasures to European museums. Two American expeditions ventured into Australian waters, one of them the U.S. Exploring Expedition in 1839, the other in 1853, when William Stimpson was aboard the U.S.N. *Vincennes*, commanded by Capt. John Rodgers.

Soon. however, Australia was supporting her own malacologists, and the collecting and study of the local faunas was being pioneered by such famous men as George French Angas, John Brazier and James C. Cox. Australia had reached its malacological maturity with the coming of that great zoologist, Charles Hedley. Today, Australian names ring loud in the halls of international malacology—Iredale, Ashby, Tate, May, Gabriel, Verco, Cotton, Macpherson, to mention only a few.

American ties with Australia are very old and strong. The Academy of Natural Sciences of Philadelphia has received a steady flow of correspondence and specimens from its Australian members since its founding in 1812. Angas, Brazier and Cox were members of our Conchological Section. Many Australian land and fresh-water molluscs were described by Academy scientists, such as Isaac Lea and Timothy Conrad. It seems poetic justice that the first Secretary of The Malacological Society of Australia was, before her marriage to D. I. Hartley, an American citizen.

Your Society and new Journal are destined to serve well your great country and its many workers. The rest of the malacological world joins in wishing you the blessings of co-operation, the enjoyment of the years of labour ahead, and the satisfaction of scientific accomplishments.

R. TUCKER ABBOTT, Ph.D.,
Pilsbry Chair of Malacology.
Academy of Natural Sciences of Philadelphia.

25th June, 1957.

FOREWORD

For half a century enthusiastic Conchologists have met together as kindred spirits, in societies, sections, clubs or informal gatherings in most Australian States to discuss their mutual interest. It is these internationally famous pioneers, Charles Hedley, Tom Iredale, Joyce Allan, John Brazier, Charles Gabriel, William Lewis May, Julian Edmund Tenison-Woods, William Tomson Bednall, Sir Joseph Verco, mentioning just a few, to whom the Conchological world, and particularly Australia, is deeply indebted.

On the 23rd of October, 1953, a band of seven enthusiasts founded in Melbourne The Malacological Club of Victoria, which enjoyed four successful years, and has the honour of being the forerunner of the Malacological Society of Australia, which held its first Annual Meeting in December, 1956, an important milestone in Conchological history.

Most will agree that the achievement of this worthy end has been largely due to the wholehearted and untiring work of the foundation President and his wife, the Secretary-Treasurer, both of whom have spared neither time, nor effort, nor finance, to bring the organisation into being.

Gathered together into one Society, we have over one hundred members dispersed throughout Australia, with representatives in every State and in many overseas countries.

The stage is now set in Australia to analyze the work of the widely informed pioneers by adding the knowledge of specialists of the era and by interpreting the valuable contribution this centre of Molluscan life can furnish.

We are happily placed in that off the coast of our continent we have huge faunal areas of rich material. These comprise the Dampierian Province extending from Geraldton to Cape York, with its rich tropical, widely-dispersed fauna; the Banksian Province from Cape York to Gladstone, with its Pacific fauna; the Solanderian Province covering the largest coral reef in the world; then the most interesting and truly Australian Provinces of Southern Australia, the Eastern Peronian; the Tasmanian Maugean and the Southern Australian Flindersian extending down from Melbourne to Geraldton. These Southern Provinces have so many unique shells, survivals from the past, and new species to be discovered that probably more valuable work could be done here than in any part of the world.

It is to be expected that this new venture in publications, "The Journal of The Malacological Society of Australia," here introduced, will live to record many valuable and interesting accounts of our native molluscs, and it is hoped that its future pages may contain many field observations of the living animal, a branch of our study hitherto somewhat neglected.

In conclusion, it is the wish of all that, stimulated by the added interest offered in this new society, Australian Conchologists will be able to meet together regularly and to discuss their studies on an interesting basis.

BERNARD C. COTTON, F.R.Z.S.,
Curator of Molluscs,
South Australian Museum, Adelaide.

SOME OPISTHOBRANCHIA (CLASS GASTROPODA) NEW TO AUSTRALIA OR OTHERWISE OF INTEREST

By JOYCE ALLAN, F.R.Z.S.*

Following my usual practice when possible, colour sketches and notes were made at the respective times some of the following species of Opisthobranchia were brought under my notice. These have been used in the preparation of this short paper, particularly in placing the first two species on record from Australia for the first time.

Family **PLEUROBRANCHIDAE**

OSCANIUS MAMILLATUS Quoy and Gaimard
(Figure 1)

Oscanius mamillatus Quoy and Gaimard, 1833, *Voy. "Astrolabe," Zool.* II, p. 294, pl. 22, f. 6. Port Louis, Mauritius.

Animal very large, soft and tubercular, with a few larger conic tubercles scattered in places on the dorsal surface. Head tentacles united at the base; foot broad, rounded, and extended only very slightly behind when the animal was immobile. The animal was remarkable for its colour and pattern. General colour was light creamy fawn to palest pink in places, with large dark brown patches at intervals round the mantle edge. The tubercles were variegated with brown and yellow, and the intervals between them were reddish brown and yellow, with dark brown, irregular rings round the basal parts of the larger conic tubercles. Conspicuous along the mantle, head, and scattered elsewhere on the brown marginal patches were small white blotches and spots. These gave a peculiar "frothy" appearance to the animal on first glance, which temporarily detracted somewhat from its true appearance. Outstanding colour marking was that of a number of conspicuous, roughly crescent shaped splashes of crimson lake scattered here and there over the dorsal surface, with somewhat darker edges. Tentacles were dark brown outlined with darker red-brown.

Length of animal: Approximately 6 inches; *breadth*: 4½ inches.

Locality: Gunnamatta Bay, Port Hacking, south of Sydney, Australia. Amongst seaweed on the tidal flat at lowest tide level. 1st April, 1946.

Remarks: A large number of these was noticed by officers of the C.S.I.R.O. Fisheries Division (Gunnamatta Bay), who recognised them as "new arrivals" to the tidal flat there, but by the time I was notified the returning tide had swept them from sight. However, the following day a few more were seen on the flat at low tide, and one was collected and sent to me for identification. By the time I was available to go down myself, they had completely vanished, and, despite periodic searching, they do not appear to have been seen since that time to my knowledge. Their habitat is obviously well below low tide level. The plum-coloured *Oscanius hilli* Hedley was also about the flat in numbers at that time. Although permitting recognition of this species on sight, Quoy and Gaimard's figure indicates that the larger conic tubercles are more erect than in the specimen I had before me, but this was no doubt due to the soft, sluggish state in which the latter was found at Gunnamatta Bay. The tissues were extremely

* Former Curator of Shells, Australian Museum, Sydney, N.S.W.

soft, and the larger tubercles were relaxed and lying almost immersed amongst the smaller ones.

It is herewith recorded for the first time from Australia, and, as far as I know, from the Pacific.

Family **POLYCERIDAE**

CRIMORA LUTEA Baba

(Figure 2, 2a)

Crimora lutea Baba, 1949. *Opisthobranchia of Sagami Bay* (Tokyo), pp. 133-134, pl. X, f. 35. Off Kurosaki, Sagami Bay, Japan.

The species recorded here as an Australian record resembles Baba's figure and description closely, except apparently in size. The yellow to orange ground colour, blue-black spots and papillae, similar tufted blackish outgrowths along the dorsal centre of the tail, the dark gills on two projections from the back flanked on each side by two yellow protuberances, and the expanded head veil with blackish outgrowths, coincide well with the Japanese species. I noticed a peculiar feature on the two specimens forwarded to me (one much smaller) was a series of small compartments or pockets running down each side of the foot sole for about one-third its length (2a). I have no recollection of seeing that exactly on any nudibranch before, and neither Alder and Hancock (1862, *Ann. Mag. Nat. Hist.* 3, X, pp. 261-265) in their description of their genus *Crimora*, in which Baba places his species, or Baba himself mentions them, yet they are of some consequence in the specimens in question, I feel sure. A letter of mine to Dr. Baba (Tokyo) in 1956 regarding this feature has been recently returned to me marked "unknown."

Length of animal: In preservative 3 inches, smaller specimen one inch. Baba gives the length of his species as 3 mm., which may be a mistake, as that seems very minute, although his figure gives the impression it is only small.

Locality: Rodd's Harbour, Port Curtis, Queensland. In sandy mud, in small rock pool left by tide at very low level. Collected by John Bates, 8th June, 1952.

THECACERA PENNIGERA (Montagu)

(Figure 3, 3a)

Doris pennigera Montagu, 1815. *Trans. Linn. Soc.* (Lond), XI, 17, pl. IV, f. 5, Devon, England.

Thecacera pennigera Fleming, 1828. *Hist. Brit. Anim.*, 283.

Thecacera pennigera Alder and Hancock, 1855. *British Nudibranchiate Mollusca,* Mon. Fam. I, pl. XXI, f. 7.

The species *Thecacera pennigera* (Montagu) cannot be mistaken, and it must have been introduced into Australia in very recent years. A brief mention of it was made by Mr. F. E. Allen (1952, *Austr. Journ., Mar. Frhwat Res.*, 4(2), 307, 308), after I had confirmed its identification, but as I prepared a colour sketch at the time and a few notes which are available for reference, I am now elaborating on Mr. Allen's brief mention of the species.

The animal has a delicate, gelatinous white body, profusely marked with bright orange spots and dashes, with velvety black ones between them; large orange patches of the gills, round rhinophores, on dorsal protuberances, and posterior to the gills on each side. Tail is long and

pointed, the tip of which the animal uses to extend and balance itself from an object to which it may be clinging. Foot sole sparsely dotted with orange and black spots. Rhinophores set in widely expanded sheaths. Three tripinnate gills arise from a common stalk on the dorsal surface. All the above features are in common with those in the British species. Branchial appendages are set a little behind and on each side of the branchia.

Length of animal: Alive 1½ inches.

Locality: Found at White Bay Power Station, upper reaches of Sydney Harbour, Australia, 28th July, 1951. Collected by Miss B. Dew, C.S.I.R.O. Fisheries Division, during sea-water conduit inspections.

Remarks: An active, brilliantly marked animal unlike any other known species occurring here. The specimen brought to me, of which I made a colour sketch at the time, lived actively in a jar of seawater until 7/8/51.

During that time it laid an irregular creamy-yellow egg-girdle (3a). Some days later Miss Dew found more specimens of the species breeding in the same locality. Its appearance, or more correctly its observance in Sydney Harbour, was certainly a surprise, but obviously shipping played a strong part in its introduction from overseas. Certain molluscs of the Indopacific do appear at intervals in Australia, but a British species that survives and breeds under such different conditions is of interest especially to the student of marine zoogeographical problems.

As I said above, a brief mention of observing this nudibranch in Sydney Harbour for the first time was made by Mr. F. W. Allen, but above notes and illustration further substantiate his record of it in South Pacific waters.

Family **PHYLLIDIIDAE**

PHYLLIDIA ELEGANS Bergh

Phyllidia elegans Bergh, 1896. *Bidrab til en Monograph of Phylliderni, Naturhist. Kjobenhavn*, Ser. 3, Vol. V, pp. 357-542, Tab. XVIII B, XIX, Philippines.

Locality: Hayman Island, Queensland. Collected A. W. C. de Witte, August, 1956.

This specimen of nudibranch was exhibited by Dr. D. F. McMichael at the August monthly meeting of the Linnean Society of New South Wales last year as a new specific record for Australia. Notification of it appeared in *Abstr.* 662, *P.L.S.N.S.W.*, 29th Aug., 1956, and later (1957 *Proc. Linn. Soc.*, 81, 3, 316-317) in the same abstract form. The genus is already recorded from Western Australia, where *Phyllidia varicosa* Lamarck, 1801, is listed from Dampier Archipelago. Whether that species in Western Australia has been correctly named remains to be seen. It may later be found that the two species, from east and west of the continent, are the same species, which is not unlikely. The species *P. varicosa,* which Eliot (*Some Nudibranchs from East Africa and Zanzibar*, 1904, *Proc. Zool. Soc.*, Lond., 268-298) described as having a broad black line running along the foot (sole) and is absent from several other species of *Phyllidia,* I believe is close to the species *P. elegans*. A detailed comparison between the so-called Western Australian *P. varicosa* and the Queensland species recorded as *P. elegans,* which incidentally has the same black line on the foot sole, would confirm their true identification, and their relationship, if any other than generic, to one another.

As it now stands, *P. elegans* Bergh, is a specific record for Australia and a generic record for all Australia except Western Australia.

Family **DORIDIDAE**

GLOSSODORIS WESTRALIENSIS O'Donoghue

Glossodoris westraliensis O'Donoghue, 1924. *Trans. Linn. Soc.*, Lond., XXXV, pp. 554-556, Abrolhos, Western Australia.

Locality: Hayman Island, Queensland. Collected by A. W. C. de Witte, August, 1956.

This specimen from Queensland was exhibited also by Dr. D. F. McMichael at the August monthly meeting of the Linnean Society last year, and was recorded in the same Abstracts as a new record for Queensland. The species *Glossodoris westraliensis* has hitherto been recorded from Western Australian localities only. It may be found eventually in North Australia, thus providing the species with a more continuous range than the rather interrupted one this eastern record sets.

Dr. McMichael brought this to my attention recently in the Australian Museum as an interesting eastern record. The specimen is typical in size, colour, pattern and general structure of the Western Australian form, of which I have already given a colour illustration (*Australian Shells*, 1950 pl. 28, f. 11), and further description is not necessary here.

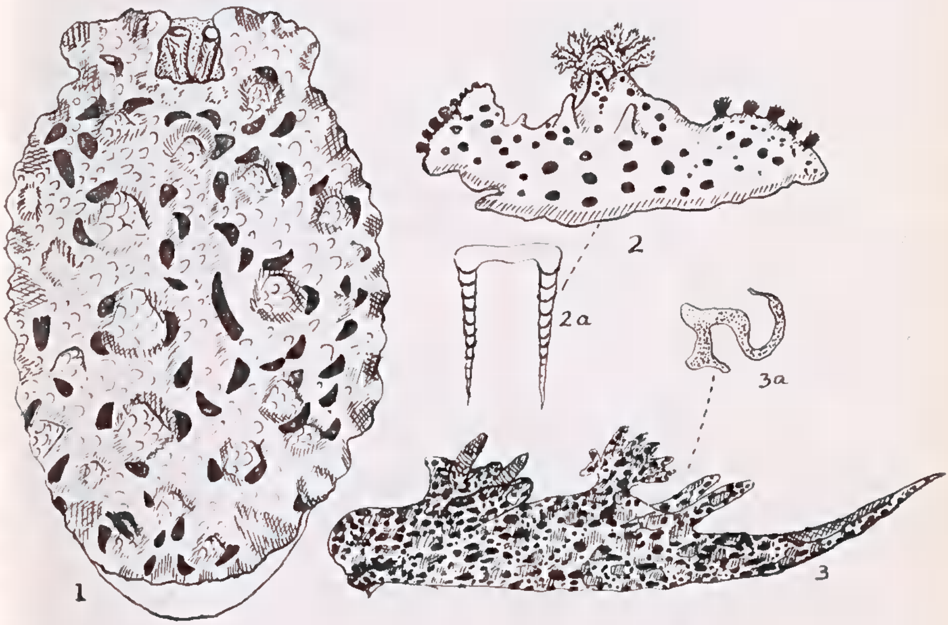
Family **FLABELLINIDAE**

FLABELLINA IANTHINA Angas

Flabellina ianthina Angas, 1864. *J. de Conch.*, ser. 5, Tom. iv., p. 66, pl. VI, f. 6. Watson's Bay, Sydney Harbour (Port Jackson), Australia.
? *Pteraeolidia semperi* Baba, 1949. *Opisthobranchia of Sagami Bay* (Tokyo).

The ability of this nudibranch to display at intervals beautiful and brilliant luminosity with a constant colour change is remarkable. It can be olive-green or blue or completely liver coloured, but can quickly change to opalescent violet and violet-blue shades, in which state it becomes a creature of great beauty. It is probably the largest of the Aeolid Nudibranchia found in Australia, and also one of the rarer ones.

Fortunately, I had a living specimen of this in the Australian Museum when I received a copy of *Opisthobranchia of Sagami Bay* (Tokyo), 1949, in which Dr. Baba (p. 182, pl. XLIX, p. 165) describes and gives a good illustration of a specimen he identifies as *Pteraeolidia semperi* (Bergh), 1870. The Sydney species during its captivity showed several changes, finally becoming partly, then completely, olive-fawn, progressing from that to an all-over violet-blue greenish shade, similar to that which Baba shows in his illustration, which, when compared with the former, would give the impression it had been prepared from the actual living specimen from Sydney. Taking external features into consideration, and finally the unusual violet-blue with a tinge of green colour, leads me to think that the Japanese species is the same as *Flabellina ianthina* Angas, 1864, one of our rarer Aeolid Nudibranchia. I am therefore synonymizing them tentatively, and, if I am correct in this, the latter name has priority over that given to the Japanese species.



AUSTRALIAN OPISTHOBRANCHIA

Fig. 1—*Oscanius mamillatus* Q. and G.

Fig 2, 2a—*Crimora lutea* Baba.

Fig. 3, 3a—*Thecacera pennigera* (Montagu).

THE LIGHTNING VOLUTE

ERICUSA FULGETRA Sowerby

By BERNARD C. COTTON,* F.R.Z.S.,
Curator of Molluscs, South Australian Museum.

The "Lightning Volute" *Ericusa fulgetra* of South Australia is keenly sought after by collectors. It was first named, described and figured in colour by Sowerby, 1825, in the Sale Catalogue of the Earl of Tankerville's collection—the only specimen then known—and it is now in the British Museum. The specimen is No. 2149 in the catalogue, and in our copy the price, £31/10/-, is written against it. Sowerby, 1847, *Thes. Conch.*, 1, p. 207, sp. 35, pl. 47, fig. 33, 34, again describes and figures the species without locality. Reeve, 1849, was the first to give the locality, "South Australia," incorrectly quoting Broderip, 1826, as the author of the species. Like many volutes, the mature shell varies in size, ranging from three inches to eight inches in length. It has been found right along the South Australian coast in shallow water, crawling on sand banks, but it is much more common on Yorke Peninsula and on the west coast of South Australia, particularly about Port Lincoln.

One rare variety somewhat different in shape has been found in the Great Australian Bight in 120 fathoms, inside the Western Australian border. Between Coobowie and Wool Bay, on the east coast of Yorke Peninsula, the tides sometimes form a sand-bar, which is exposed at a very low tide to the heat of the sun. When the sea begins to cover the bar, as the tide rises, these volutes and also such shell as the "False Helmet" (*Hypocassis bicarinata*) and "Lyre Shells" (*Lyria mitraeformis*) emerge from the sand. A dozen or so "Lightning Volutes" have been taken in a few hours. The late Sir Joseph Verco described eight varieties of this remarkable Volute shell.

The typical "Lightning Volute" is not found in deeper waters where specimens are usually found of the *dictua, lunisligata* or *connectens* varieties. There is some variation in shape, but the plate reproduced here shows the respective colour patterns.

An interesting specimen taken by Jim Veitch starts off in life as a typical *E. fulgetra lunisligata*, but after an accidental break in the shell, it continues as a typical *E. fulgetra*. This change in colour scheme frequently occurs in variable patterned shells following a repair after damage.

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* Adelaide, South Australia.

EXPLANATION OF PLATE.

Fig. 1. *The Lightning Volute, Ericusa fulgetra* Sowerby. Typical, axially flamed.

Fig. 2. *The Crescent Volute*, variety *lunisligata* Verco, 1912, with two spirals of large crescentic or arrow-headed spots.

Fig. 3. *The Spotted Volute*, variety *punctisligata Verco*, 1912, with two rows of small spots.

Fig. 4. *The Two Banded Volute*, variety *bicincta* Verco, 1912, with two spiral bands only.

Fig. 5. *The Three Banded Volute*, variety *tricincta* Verco, with three spiral bands.

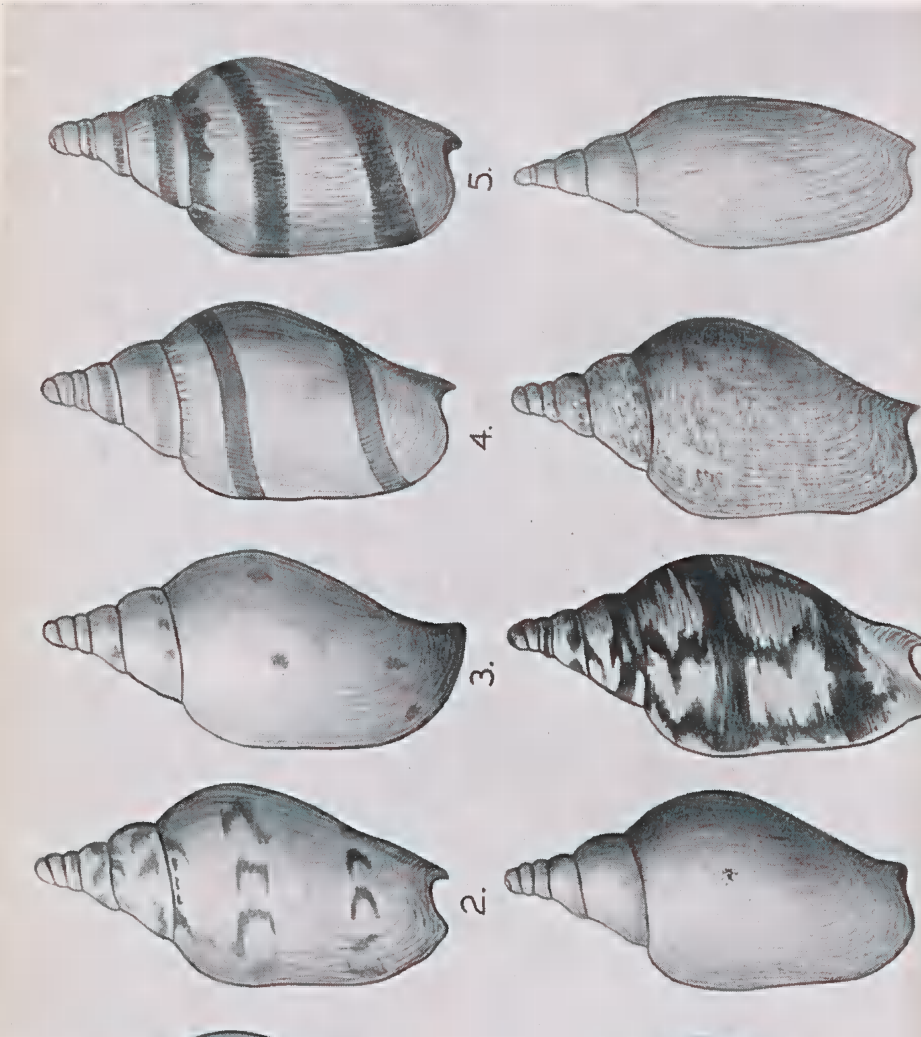
Fig. 6. *The One Banded Volute*, variety *unicincta* Verco, 1912, with only a lower spiral band present.

Fig. 7. *The White Volute*, variety *alba* Verco, 1912.

Fig. 8. *The Connected Volute*, variety *connectens* Verco, 1912, with two continuous spiral bands crossing the normal axial flames.
This is a rare variety, usually very small in mature size. Here is figured the largest and best specimen ever seen, six and a quarter inches long, dredged alive by Mr. J. Veitch at Port Lincoln.

Fig. 9. *The Net Volute*, variety *dictua* Verco, 1909. The type was taken in a cray-pot off Granite Island, Port Victor. It is not infrequently obtained under similar circumstances in the same locality. It has a delicate, lace-like pattern instead of the bold zig-zag axials of the typical variety.

Fig. 10. *The Boat Volute, Ericusa orca* Cotton, 1952. This is the rare, deep water relative of *E. fulgetra* from the Great Australian Bight. It is differently shaped from the typical *E. fulgetra*.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ON SOME OPISTHOBRANCHIA FROM VICTORIA

By ROBERT BURN†

(Read 25th March, 1957)

INTRODUCTION

This paper presents the information gained from the examination of a collection of Opisthobranchia taken by the author at a number of localities along 120 miles of coastline centering on Port Phillip Heads, Victoria.

The results have been rather gratifying; 35 species, of which 10 are described as new, are recorded. One new genus is described and 22 recorded. Most specimens were collected at low tides under stones, but some were collected at dusk when the animals crawl about feeding on the various seaweeds. These nocturnal specimens were easily picked off the seaweed and placed in a jar of seawater for later study.

One comes to the conclusion from the type of species collected that the waters along the Victorian coastline are gradually warming up. Tropical and sub-tropical genera found here, although not as large as from warmer seas, are now appearing in our waters. Some such genera are *Aglaia, Cyerce, Glossodoris, Thordisa, Madrella, Melibe* and *Hervia.* Some species prove so common all the year round that it seems unlikely that they should not have been previously recorded.

Since this paper was written, a further number of species have been collected which are not recorded in this paper; some appear to be new species. These will be presented in a later paper.

Dimensions mentioned in descriptions are of the largest specimens so far collected by myself.

Type specimens are to be presented to the National Museum, Melbourne, Victoria.

SYSTEMATIC LIST OF OPISTHOBRANCHIA FROM VICTORIA

* Denotes species not previously recorded from Victoria.

	Phylum	MOLLUSCA
	Class	GASTROPODA
	Subclass	OPISTHOBRANCHIA
I	Order	Cephalaspidea
	Sub Order	Philinacea
	Family	Philinidae
		Philine angasi (Cross & Fischer)
	Family	Aglaiidae
		* *Aglaia taronga* Allan
II	Order	Anaspidea
	Family	Aplysiidae
		Aplysia parvula Morch
		* *A. angasi* Sowerby
III	Order	Sacoglossa
	Sub Order	Elysiacea
	Family	Calliphyllidae
		* *Cyerce nigra pallens*, subsp. nov.

† Geelong, Victoria, Australia.

IV	Order	Notaspidea
	Sub Order	Pleurobranchacea
	Family	Pleurobranchidae
		* *Pleurobranchus punctatus* Quoy & Gaimard
		* *Pleurobranchaea novaezealandiae* Cheeseman
V	Order	Nudibranchia
	Sub Order	Doridacea
	Super Family	Eudoridacea
	Group	Phanerobranchia
	Family	Euphuridae (= Polyceridae)
		* *Euphurus multidigitalis,* sp. nov.
		* *Palio cooki* (Angas)
		* *Nembrotha arnoldi,* sp. nov.
	Group	Cryptobranchia
	Family	Doridae
		* *Glossodoris victoriae,* sp. nov.
		* *G. tasmaniensis* (Bergh)
		* *Glossodoris perplexa,* sp. nov.
		* *G. haliclona,* sp. nov.
		* *G. alternata,* sp. nov.
		Ceratosoma brevicaudatum Abraham
		* *Rostanga arbutus* (Angas)
		* *Praegliscita,* gen. nov.
		Type species
		Doris chrysoderma (Angas)
		Alloiodoris marmorata Bergh
		Staurodoris pustulata (Abraham)
		Archidoris varia (Abraham)
		* *Thordisa sabulosa,* sp. nov.
		* *Halgerda graphica* Basedow & Hedley
		* *Dendrodoris aurea* (Quoy & Gaimard)
		D. carneola (Angas)
		D. nigra (Stimpson)
		* *D. staminea* (Basedow & Hedley)
		* *D. albopurpura,* sp. nov.
		* *D. davisi* Allan
	Sub Order	Arminacea
	Super Family	Pachygnatha
	Family	Madrellidae
		* *Madrella sanguinea* (Angas)
	Sub Order	Dendronotacea
	Family	Tethyidae (= Fimbriidae)
		* *Melibe australis* Angas
		* *M. pellucida,* sp. nov.
	Sub Order	Eolidacea
	Super Family	Cleioprocta
	Family	Facelinidae
		* *Hervia ornata* (Angas)
		* *H. newcombi* (Angas)
		* (?) *H. peonicia,* sp. nov.

VICTORIAN SPECIES

PHILINE ANGASI (Crosse & Fischer)

Bullaea angasi Crosse & Fischer, 1865, *Journ. de Conch.*, 13, p. 38, pl. 2, f. 8.

Large, elongate oval body, up to 60 mm. in length. Very slimy. Colour white with very little variation. Shell large, upward of 20 mm. long; internal, covering the posterior disk; transparent white in colour; large body whorl and aperture, very thin and frail. Radula formula 24 x 1.0.1.

Locality: Port Phillip Bay.

Station: Very common; sand bars; sandy mud flats and shallow water dredgings.

AGLAIA TARONGA Allan

Aglaia taronga Allan, 1933, *Rec. Aust. Mus.*, 18, No. 9, p. 444, pl. 56. f. 1-3.

Small; body cylindrical, divided into anterior and posterior disks. Shell very small, white, few whorled without a spire, on right hand side of rear of posterior disk. Gill long, plumose, passing across the body under the shell, protected by the tail lobes of the posterior disk. Colour velvet black, edges of lobes white with a secondary row of orange; either side of the anterior disk lined with an orange streak. There is an interrupted white hair line from the mouth to the very dark tail of the anterior disk. Upper exposed surfaces with general yellow flecking. Inner surfaces light grey. Size of above described specimen 22.5 x 9 mm.

Locality: Swan Bay, Port Phillip (1 spec. Dec., 1956).

Station: Very uncommon; crawling on *Posidonia* at low tide.

Remarks: There are probably a further two species of *Aglaia* occurring in Victoria, but at present they are undescribed or unidentified.

APLYSIA PARVULA Morch

Aplysia parvula Morch, 1863, *Journ. de Conch.*, p. 22.

Body small, up to 88 mm. in length; long narrow neck with large rhinophores and cephalic tentacles; parapodia medium, united behind, not used for swimming; mantle with a large aperture through which crown of shell protrudes; with a small purple gland; and a sucking disk on the posterior end of the foot. Colour fawn to dark brown, blotched with white; edges of parapodia, rhinophora, siphon and cephalic tentacles always edged with black. Mantle aperture edged with black, from which white patches radiate to give a rayed effect. Shell small, up to 22 mm. long by 10 mm. wide, strongly convex, horny and rather tough in texture; colour brown. Radula formula 15-20 x 12.1.12.

Locality: Torquay, Apollo Bay, Barwon Heads, Flinders.

Station: Common, under stones and crawling on weed on open coast reefs. During December, 1956, large number of minute specimens of this species were observed in every pool at Torquay; sizes ranged from 3 mm. to 10 mm. in length.

Remarks: *Aplysia norfolkensis* Sowerby, 1869, from Sydney, appears very similar to *A. parvula* Morch, a species of apparent world-wide distri-

bution. Radula features are similar, that of the latter ranging from 22 x 12.1.12 to 35 x 18.1.18, while the former is 15-20 x 12.1.12. It would then appear that *A. parvula* is the correct name, as it has six years' priority.

APLYSIA ANGASI Sowerby

Aplysia angasi Sowerby, 1869, *Conch. Icon.*, 17, pl. 8, sp. 35. Body small, plump or rounded, upward of 100 mm. Parapodia rather large, separated behind. Mantle aperture nearly closed, with a small papilla at the spot. Siphon large. Rhinophores long and linear. Cephalic tentacles short, irregular along the outer edges. Penis cylindrical, 10 mm. long; a curved spur 4 mm. long extends from the papilla on the round end. Penis protrudes from the genital groove anteriorly between the head and the foot. Foot without a sucking disk. Gill large, never extended or exposed. Shell small 25 x 17 mm., elongate-oval, slightly convex, thin, transparent and frail. Radula formula 33 x 25.1.25. Colour varying from fawn to brownish-green, always with a few darker brown patches on the parapodia and neck; exposed surfaces covered with fine, dark brown interlacing veins. Gill olive. Inner surfaces of parapodia fawn without markings. Foot yellow, vacant of markings. Shell brown.

Locality: Torquay (3 spec. Dec., 1956).

Station: Uncommon, clustered together under stone, mid-tide.

Remarks: Yet another species is recorded from Victoria as *A. tigrina* Rang (correctly *A. sowerbyi* Pilsbury). This is incorrect, as the Victorian species is not the same as the species from New South Wales. But until further material comes to hand the naming of the Victorian species must be left in abeyance.

CYERCE NIGRA PALLENS, subsp. nov.

(Pl. III, fig. 8-11)

General body shape typical of *Cyerce*, 50 mm. long and 20 mm. wide excluding the branchial papillae. Head with corners produced to form linear orals. Rhinophores solid, cylindrical, medium length, bifurcated at the upper end. Branchial papillae in eight rows along the mantle-margin; attaining largest size posteriorly in the inner row. Branchial papillae medium, foliaceous, caducous; consisting of a short stalk and a large broadly lachrymose leaf-like lamina, finely denticulated along margins; the liver ramifications visible in each lamina. Foot broad, antero-lateral corners nearly square, notched anteriorly, tapering to a blunt point behind. Genital oriface below and posterior to the rhinaphores. Pericardium large, soft and balloon-like, pulsates as the animal breathes. Colour generally velvet-fawn, dorsum salmon pink flecked with white, foot fawn speckled with minute brown spots. Branchial papillae olive-fawn marked with short light blue streaks on the upper side, and on the reverse side with small light blue dots.

Locality: Queenscliff (4 spec. Oct-Nov., 1956; 5 spec. May, 1957).

Station: Rather rare, crawling on seaweed at extreme low tide.

Remarks: Differs from the true *C. nigra* Bergh, 1877, in being much paler, particularly in the dorsal area. The patterning on the branchial papillae also differs considerably from the true species in general position of markings. This variety may warrant specific rank rather than just variental status. This is the most southern record of the genus and only the second record from Australia.

PLEUROBRANCHUS PUNCTATUS Quoy & Gaimard

Pleurobranchus punctatus Quoy & Gaimard, 1832, *Voy. "Astrolabe" Zool.*, 2, p. 299, pl. 22, f. 14.

Body medium size, broadly oval, up to 44 x 32 mm., mantle large, twice as wide as foot. Ctenidium large, rachis smooth; always concealed under mantle. Rhinophores long, stout; cylindrical, longitudinally folded throughout their length. Eyes posterior to base of rhinophores. Shell small, $\frac{1}{4}$-$\frac{1}{3}$ of body length, nearly square, but slightly narrower behind; very flat, of $1\frac{1}{2}$-2 whorls, fragile. Colour pale cream to pale yellow. Shell transparent amber. Some specimens have white spots on the mantle.

Locality: Portarlington; Breamlea; Flinders; Lorne; Blanket Bay.

Station: Very common, under stones between tide levels; usually found in pairs.

Remarks: The egg ring, about 18 mm. diameter, of $\frac{3}{4}$ of one whorl, is a clear gelatinous mass enclosing the minute spheres of cream or yellow eggs. Egg rings were first observed in October, 1954, and in March, 1955, minute specimens up to 5 mm. in length appeared.

PLEUROBRANCHAEA NOVAEZEALANDIAE Cheeseman

Pleurobranchaea novaezealandiae Cheeseman, 1878, *Proc. Zool. Soc., Lond.*, p. 276, pl. 15, fig. 3.

Quite large, about 65 x 24 mm. Mantle small, not covering head or foot, but continued forward into the head-veil and posteriorly into the tail. Head-veil with corners produced to form linear tentacles; margin between tentacles finely serrated. Right margin of mantle extending over the large ctenidium. There is no shell. The sole of the foot has a pedal gland posteriorly. Colour yellowish-grey, exposed surfaces streaked with irregularly anastomosing lines of black; sole brown, ctenidium light grey. Radula formula 36 x 53-65.0.53-65 to 46 x 60-65.0.60-65.

Locality: Lorne, Apollo Bay (1 spec. from each locality, Dec., 1956).

Station: Uncommon, in sandy positions under stones near high water level.

Remarks: This species differs from the previous species in that it lacks a shell; the mantle is continuous anteriorly and posteriorly into the head and tail, and the peculiar lined colouring. The animal is predatory, eating other sea-slugs, etc., placed in an aquarium along with it.

EUPHURUS MULTIDIGITALIS, sp. nov.
(Pl. 11, fig. 1-6)

Animal limaciform, very small, about 10 x 2.5 mm. in size. Pallial ridge with 42 evenly spaced papillae, each one with 4 or 5 points resembling fingers. Dorsum separate from tail, irregularly and minutely pustulose. Foot long, narrow, deeply notched in front, foot corners rounded and curled back; grooved full length. Rhinophores small, rectractile within sheathed cavities, obliquely laminated with 12 laminae. Branchiae 3, bipinnate, sub-retractile within a small crescent-shaped cavity. Orals formed by thickened outer lips of head. Genital opening midway along length of dorsum. Colour pale yellow; pustules clear, with a black spot in each; papillae black with clear tips; rhinophores, branchiae and foot white. Underside of mantle pale yellow speckled with black; a noticeable cluster of dots in front of the head.

Locality: Torquay (2 spec. Dec., 1955).

Station: Under stone at low tide.

Remarks: The only other Australian species to date, *E. yatesi* Angas, 1864, from Sydney, is much larger, with fewer papillae surrounding the dorsum.

PALIO COOKI (Angas)

Polycera cooki Angas, 1864, *Journ. de Conch.*, 12, p. 58, pl. V, f. 6.

Body small, limaciform, about 10 mm. in length and 3 mm. in width. Dorsum separated from sides by pallial ridge, but continuous into tail. Pallial ridge consists of a row of fine-pointed serrations which gradually die out posteriorly. Rhinophores large, sub-clavate, rectractile, laminated with 8 very oblique laminae. Branchiae 5, bipinnate, retractile within a large crescent-shaped cavity. General body colour bright orange speckled with minute strawberry-red dots, foot white. Pallial ridge strawberry-red.

Locality: Breamlea (1 spec. Nov., 1955); Torquay (2 spec. Dec., 1955).

Station: Under stones near low tide.

NEMBROTHA ARNOLDI, sp. nov.
(Pl. II, fig. 13-14)

Body small, limaciform, dimensions up to 18 x 6 mm.; general form typical of *Nembrotha*. Body minutely spiculose. Rhinophores large, clavate, with 9 laminae, retractile within sheather cavities. Branchiae small, 5, tripinnate, sub-retractile arranged in a semi-circle about the small protrudent anus. Branchial cavity equipped with 3 flaps corresponding with the 3 central branchiae. Oral tentacles linear, but rather short. Genital opening large, sheathed; penis semi-transparent, stout at base and for half the length, then twisted to the rear and tapering to a sharp point. Colour varying from pink to dark brownish-red, sometimes with a few yellow markings on the sides. Rhinophores, branchiae, anal tube and orals yellow. Foot paler than upper surface, outlined with yellow.

Locality: Torquay (3 spec. Mar., 1 spec. Nov., 1956).

Station: Very uncommon, under stones at low tide.

Remarks: Differs from other Australian species in small size and rather dull colouring. This species is named in honour of the late Rev. John K. Arnold—a very good friend and capable teacher, who showed me how and where in conchological collecting.

GLOSSODORIS VICTORIAE, sp. nov.
(Pl. III, fig. 4)

Body medium size for the genus, about 30 x 7 mm., elongate-oval, mantle narrow. Dorsal surface of mantle with a few low postules, longitudinally ridged or grooved to give a rather flat corrugated appearance. Rhinophores medium, clavate, with 14 laminae, retractile. Branchiae 12, surrounding the anus. Colour white, tinted with pink; mantle and upper edge of foot encircled by a ring of large pink or red dots; grooves on mantle lined pale blue; postules on mantle tipped red. Rhinophora, branchiae, head and foot white. Radula formula 35 x 27.0.27.

Locality: Portarlington (3 spec.), Torquay (2 spec., type locality).

Station: Fairy common, under stones and on weed at low water.

Remarks: Differs from the next species in lacking red colour spots in the central dorsal area, and smaller size.

GLOSSODORIS TASMANIENSIS (Bergh)
(Pl. II, fig. 10)

Chromodoris tasmaniensis Bergh, 1905, *Reis. im. Arch. der. Phil.*, 6 (2), p. 69, pl. V, f. 12-15.

Body of above species, length up to 55 mm. Dorsal surface of mantle smooth. Rhinophores small, with 18-20 oblique laminae. Branchiae 10, surrounding large protrudent anus. Colour white, a single or double row of reddish-orange spots just inside the mantle margin; medium part of the back marked with reddish-orange spots, sometimes many, sometimes few. Upper edge of foot encircled by a row of spots as is mantle. Rhinophores white. Branchia white, rachis of each red on the inner side and with 2 red dashes on reverse side. Radula formula 42 x 34.0.34.

Locality: Torquay (1 spec. Mar., 4 spec. Oct., 1956).

Station: Common, under stones and crawling among seaweed.

Remarks: G. *tasmaniensis* Bergh, type locality Ulverstone, Tasmania, has not been collected since originally described in 1905. Specimens from Torquay, although showing certain colour variations, apparently belong to this species. Differs from the previous species in larger size and the smooth dorsal surface.

GLOSSODORIS PERPLEXA, sp. nov.
(Pl. III, fig. I.)

Body small, length up to 17 mm. General body-colour white, the median part of the back sparsely springled with red spots; a row of purple markings just inside the mantle margin. Underside of mantle similar, but markings much fainter. Sides and tail with a few red spots. Tail faintly mauve. Rhinophores red, with 6-8 laminae. Branchiae 10, yellow.

Locality: Torquay (1 spec. Oct., 1956).

Station: Very rare, crawling on seaweed.

Remarks: Somewhat similar to G. *aureopurpurea* (Collingwood), but differs in being smaller and having red dorsal spots instead of yellow.

GLOSSODORIS HALICLONA, sp. nov.
(Pl. III, fig. 2)

Body small, length up to 15 mm. General body-colour bright pink; mantle margin edged with white, inside which is a second interrupted row of white; dorsal surface minutely spotted with red. Rhinophores large, with 8-9 laminae, yellowish-pink. Branchiae 8-9, pinnate, pink.

Locality: Portarlington.

Station: Rather uncommon, alive on pink sponge *Haliclona* found under stones below low tide.

Egg ring an incomplete ellipse, 4 mm. broad and 2 mm. high; eggs cream in a clear gelatinous mass.

Remarks: Allan, 1947, mentioned a small unnamed *Glossodoris* from Angourie which may be the same as this. The colours are similar except for the mantle margins, rhinophores and branchiae.

GLOSSODORIS ALTERNATA, sp. nov.
(Pl. I, fig. 10-11)

Body small, length up to 18 mm. General body-colour mauve; medium part of mantle an irregular area of orange, with a few bright

metallic green spots; remaining portion of mantle mauve broken by white patches, which appear to radiate from some central point. Underside of mantle similar. Rhinophores rather large, with 7 laminae. Branchiae small, 6, bipinnate, sub-retractile, white. Radula formula 40 x 29.0.29; outer teeth not denticulate.

Locality: Portarlington (type locality); Torquay.

Station: Rather common, under stones and crawling on weed.

Remarks: A very distinctive little species not easily confused because of its striking colours. One specimen 12 mm. long from Portarlington had both rhinophores emerging from the one large cavity; the right-hand rhinophore was bifurcated and had laminae on both heads.

CERATOSOMA BREVICAUDATUM Abraham

Ceratosoma brevicaudatum Abraham, 1876, *Ann. Mag. Nat. Hist.*, Ser. 4, p. 142, pl. 7, and f. 6.

Body smooth, rather hard in consistency, up to 100 mm. in length. Mantle produced posteriorly into a nipple-like protuberance. Tail half as long again as mantle. Branchial plumes large, many in number, intergrown at the base, simply pinnate, retractile, surrounding anus in a semi-circle. Rhinophores clavate, retractile, with many oblique laminae. Orals stout, tapering to blunt points. General body colour pinkish-orange, profusely spotted on the sides with small red and blue spots. Mantle margin reddish, with a few dark red spots and white patches. Median part of mantle with purple or mauve spots, both large and small. Rhinophores and branchiae red. Mantle tail bright red, seemingly pustulose. Radula formula 80 x 140.0.140.

Locality: Portarlington; Shoreham; Flinders; San Remo.

Station: Fairly common, under stones between tides. One of the more common species in Western Port.

Remarks: After considering a large series of this species I have concluded that the small species from South Australia, *C. adelaidae* Basedow & Hedley, 1905, is but the juvenile of this species and should be reduced to synonymity.

ROSTANGA ARBUTAS (Angas)

Doris arbutus Angas, 1864, *Journ. de Conch.*, 12, p. 47, pl. 4, f. 4.

Length up to 40 mm., width up to 22 mm. Body broadly ovate. "Mantle covered everywhere with closely-set villous papillae strengthened by divergent spicules extending from base to apex. General integument also rich in spicules. Rhinophore—sheaths and branchial cavity papillate similarly to the general dorsum. Branchial plumes 6-9, bipinnate, arranged in a complete circle around the anus. Representative radula formula 60 x 50-60.0.50-60" (Baba, 1949, p. 149). Oral tentacles linear. Rhinophores slit in front, apex cylindrical, with very many laminae. Colour variable; usually bright red; rhinophores red with slit and apex yellow; branchiae red; base of branchial plumes black in some specimens.

Locality: Breamlea (1 spec. June, 1955); Lorne (3 spec. Dec., 1956); Blanket Bay (1 spec. Dec., 1956).

Station: Not uncommon, under stones between tides; egg rings are bright orange-red, up to 15 mm. overall diameter, of 3 or 4 whorls; the eggs are laid vertically in double rows.

PRAEGLISCITA, gen. nov.

Type species—*Doris chrysoderma* Angas, 1864.

Animal enlongate-oval, slightly narrower medianly; soft, highly convex. Mantle nodulose; nodules high, abrupt in form, apices rounded; interstices flat, smooth. Branchiae bipinnate, many in number, arranged in a complete circle around the anal papillae. Rhinophores conical-clavate, laminated. Rhinophoral and branchial cavities in centre of rather deep depressions; not sheathed but lips minutely papillate. Foot broad and flat. Head small; orals mere ridge-like expansions as in *Dendrodoris*. Genital oriface large, prominent, divided vertically by a thin membrane. Elements of labial disk simple. Radula consists of many rows of simply hamate teeth, no central tooth; first inner lateral broad with a minute hook, next four becoming narrower but ascending in size and length of hooks. Outer six descending sharply, set closely together; outer tooth minute, without a hook.

Remarks: This genus resembles *Rostanga* in the general shape of the mantle and the formation of branchial plumes, but, ventrally, it resembles *Dendrodoris* with a broad flat foot and simple ridge-like expansions for the oral tentacles.

PRAEGLISCITA CHRYSODERMA (Angas)
(Pl. 1, fig. 1-5)

Doris chrysoderma Angas, 1864, *Journ. de Conch.*, 12, p. 46, pl. 4, f. 3.

Body as for genus, up to 40 mm. in length and 16 mm. in breadth. Nodules large in median area of mantle and decrease in size towards the margins. Branchiae 7 in number, rather like segments of a cut orange with the vertical axis the rachis of each plume. Clavus of rhinophores a rounded-cone, on stalks narrower but same length as clavus; clavus with 15-20 laminae. General body-colour chrome yellow, nodules capped with white. Rhinophores and branchiae orange. Underside of mantle marked with vein-like muscle tracery. Radula formula 37 x 78.0.78; teeth as for genus.

Locality: Queenscliff (1 spec. April, 1956); Torquay (4 spec. Oct., 1956).

Station: Rather common, crawling on seaweed and stones.

Remarks: This species is apparently rare in the type locality, Sydney Harbour, as only a few specimens have been collected in the intervening 97 years since the type was taken.

ALLOIODORIS MARMORATA Bergh

Alloiodoris marmorata Bergh, 1905, *Reis, im. Arch. der Phil.*, 6, p. 42, pl. 3, f. 12-19.

Body elliptic, rather firm, up to 26 mm. long and 15 mm. broad. Mantle has a rather matt appearance. Foot notched anteriorly. Orals digitiform. Rhinophores clavate, retractile, laminated. Branchiae 7-8, retractile, tripinnate. General body colour grey, mantle and sole minutely speckled with dark brown; dorsal surface with numerous white spots, each surrounded by an area of dark brown. Underside of mantle marked with a few dark brown spots. Rhinophores and branchiae dark brown. Radula formula 39 x 19.0.19.

Locality: Portarlington; Sutherlands Bay, Phillip Island.

Station: Common, under stones between tides.

Remarks: This species, although rather drab dorsally, is very sharply defined ventrally.

STAURODORIS PUSTULATA (Abraham)

Doris pustulata Abraham, 1877, *Proc. Zool. Soc.*, p. 205, pl. 29, f. 18-19.

Length up to 45 mm., breadth 30 mm. Body broadly elliptic, rather firm. Mantle covered by numerous opaque warty tubercles of various sizes, sharply defined in appearance, larger on the median part, more numerous towards the margins. Rhinophores clavate, laminated, retractile. Branchiae 8, tripinnate, retractile along with the anal tube. Rhinophoral cavities each surrounded by a ring of pustules. Branchial cavity elliptic, transverse to the body, surrounded by a ring of postules. Foot narrow, upper laminae notched; orals stout, digitiform. General body-colour yellow-orange; rhinophores fawn; branchiae fawn or brown. Radula formula 26 x 38.0.38.

Locality: Flinders; Torquay; Blanket Bay.

Station: Extremely common, under stones near low tide level.

ARCHIDORIS VARIA (Abraham)

Doris variabilis Angas, 1864, *Journ, de Conch.*, 12, p. 44, pl. 4, f. 1, preocc.

Doris varia Abraham, 1877, *Proc. Zool. Soc.*, p. 209.

Body elongate-elliptic, wider in front than behind, up to 22 mm. in length. Mantle soft, covered with a multitude of varying-sized flat-topped nodulations; very close together. Branchiae 5, trippinate, sub-retractile; anal papilla frilled around edge. Branchiae surround anus in a semi-circle. Rhinophores clavate, with 10-12 laminae, retractile within cavities lipped with a row of co-joined nodules. Foot narrow, bi-laminate; head large; orals large, broadly triangular. Colour fawn-orange or greenish-fawn, always appearing blotchy. Rhinophores and branchiae lighter than body-colour. Radula formula 37 x 65.0.65.

Locality: Breamlea (2 spec. Oct., 1956); Queenscliff (6 spec. Nov., 1956).

Station: Common, crawling on seaweed in pools.

THORDISA SABULOSA, sp. nov.

(Pl. I, fig. 6-9)

Length up to 22 mm., width 14 mm. Animal broadly oval or roughly square. Mantle entirely covered with thick-set pointed papillae, margins finely denticulate. Branchiae 6, bipinnate, retractile, surrounding anal tube. Branchial cavity with 6 distinct triangular lobes corresponding to the gaps between plumes. Rhinophores linear, clavus slightly larger than stalk, with approximately 20 very fine laminae, retractile. Foot narrow, grooved; head large, rounded; orals linear. General body colour ochraceous-yellow; dorsal papillae bright yellow; underside of mantle with numerous laterally-placed dark brown spots; rhinophores fawn, laminae of clavus dark brown; branchiae fawn. Radula formula 46 x 36-41.0.36-41. Teeth simply hamate, hooks very elongate. Innermost lateral minute, next 14 ascending in size: outer 6-7 laterals descending, faintly split at the tips.

Locality: Torquay (type locality, 1 spec. Nov., 1956); Queenscliff (1 spec. Nov., 1956).

Station: Rare, under stones in sandy positions, low tide.

Remarks: The animal exudes an adhesive fluid from the papillae on the mantle. These in turn become thickly encrusted with grains of sand and give the animal a much different appearance. This species, because of the spear-head papillae or spikes covering the mantle, cannot readily be confused with any other southern Australian nudibranch described to date.

HALGERDA GRAPHICA Basedow & Hedley

Halgerda graphica Basedow & Hedley, 1905, *Trans. Roy. Soc.*, S. Aust., 29, p. 152, pl. 3, f. 1-4.

Body small, soft, elliptic; up to 15 mm. in length. Mantle minutely granular. Rhinophores clavate, small, retractile, laminated. Branchiae 6, small, bipinnate, very distinct. General body-colour pale yellow; mantle with numerous evenly spaced black spots (without the red lines as has the type); underside of mantle with a number of black spots; foot and orals outlined with pale orange. Rhinophores and branchiae black. Radula formula 40 x 40.0.40.

Locality: Torquay (1 spec. Feb., 1954).

Station: Rare, under stone in running water, low tide.

DENDRODORIS AUREA (Quoy & Gaimard)

Doris aurea Quoy & Gaimard, 1832, *Voy. "Austrolabe," Zool.*, 2, p. 265, pl. 19, f. 4-7.

The species of this genus have the following characteristics in common: Body soft, slimy, elongate-elliptic; mantle broad, usually smooth; rhinophores large, laminated, retractile; branchiae large and bushy, up to 8 in number, tri-or quadipinnate, retractile, surrounding anal papillae. Foot broad and smooth; head small; orals short, ridge-like. There is no radula.

This species is about 55 mm. long. Head very small. Branchiae large and bushy, 5 in number. Rhinophores small for the size of the animal. Mantle smooth or minutely blistered. General body colour orange with or without small white patches on the mantle. Rhinophores and branchiae light brown.

Locality: Portarlington.

Station: Rather common, under stones between tides.

Remarks: Egg ring consists of 2 spiral whorls, overall diameter 50 mm., depth 10 mm., width 1 mm.; of some hundreds of vertical rows of minute yellow eggs, 15 eggs to a row.

DENDRODORIS CARNEOLA (Angas)

Doris carneola Angas 1864, *Journ. de Conch.*, 12, p. 48, pl. 4, f. 7.

Length up to 40 mm. Mantle tough. Back smooth or minutely granular. Branchial plumes 5, tripinnate. Head small, orals ridge-like. General body-colour dull red dorsally, yellow ventrally; specimens may be cream or orange. Rhinophores and branchiae brown.

Locality: Portarlington, Flinders

Station: Rather common, under stones between tides.

DENDRODORIS NIGRA (Stimpson)

Doris nigra Stimpson, 1855, *Proc. Acad. N.Sc., Philad.*, 7, p. 380.

Length up to 55 mm.; bath smooth, with a few indistinct large blisters. Branchiae 6-8, very large and bushy, quadripinnate. Colour velvet-black dorsally, lighter ventrally. Mantle, foot and orals outlined with crimson. Rhinophores grey, tipped with red; branchiae grey outlined with white.

Locality: Portarlington (Jan.-Apr., 1954).

Station: Rather uncommon, under stones between tides.

Remarks: During the period mentioned above this species was very common, but since then has not again been collected. *Doriopsis australaensis* Abraham, 1877, p. 243, from N.S.W., is apparently the juvenile of this species.

DENDRODORIS STAMINEA (Basedow & Hedley)

Archidoris staminea Basedow & Hedley, 1905, *Trans. Roy. Soc., S. Aust.*, 29, p. 151, pl. 6, f. 3-4.

Length up to 22 mm. Mantle covered with very numerous small tubercular elevations and depressions; to the touch rather like medium sandpaper. Underside of mantle with the distinctive "vein-like threadlets" of the type description. Rhinophores clavate, retractile, laminated. Branchiae 5, small, tripinnate, retractile. Orals rounded rather like leaves. General body-colour yellow or white, occasionally streaked with red. Rhinophores and branchiae brown or yellow.

Locality: Portarlington; Flinders.

Station: Common, under stones between tides.

Remarks: This species was originally described as *Archidoris*, and as there is no radula mentioned I assume that the species was placed there only by external features. Upon dissection of specimens I find there is no radula, which places the species in *Dendrodoris*.

DENDRODORIS ALBOPURPURA, sp. nov.
(Pl. III, fig. 3, 12)

Length up to 75 mm. Back covered by numerous large, flat, blister-like postules. Rhinophores large, retractile, with 12 laminae; clavus at right-angles to stalk. Branchiae 5, large and bushy, tri-pinnate. Foot narrower in front than behind. Head small; orals ridge-like as usual. General body-colour dirty white (pale grey); each blister-like pustule capped with a purple spot. A few brown spots, each surrounded by a white area, are scattered over the median part of the back. Underside of mantle and sides of foot scattered with a number of minute brown spots. Clavus of rhinophores purple, stalks white. Branchiae white. General shape when crawling very elongate.

Locality: Flinders

Station: Rare, under stones at extreme low tide.

Remarks: This species has very little adhesion in the foot. Specimens are collected in the swirling water and sand beneath upturned stones. In an aquarium this species is very active. This species differs from the other Victorian species in its larger size, bent rhinophores and lack of adhesion in the foot.

DENDRODORIS DAVISI Allan

Dendrodoris davisi Allan, 1933, *Rec. Aust. Mus.*, 18, No. 9, p. 447, pl. 56, f. 13-14.

Length up to 20 mm. Mantle broad, soft; "densely covered with large, soft, raised pustules, with smaller ones between them" (*Allan*, 1933, p. 447). Branchia large, 5, tripinnate, retractile. Rhinophores large, with 8 laminae, retractile. Head large, orals ridge-like as usual. General body-colour dirty yellow; median part of mantle greenish. Rhinophores and branchiae dirty yellow, sometimes tinged green.

Locality: Portarlington.

Station: Common, under stones near low tide level.

Remarks: The pustules on the back accumulate a brown mucous or sediment, which is particularly noticeable on the median part. This species, except for its softness, would pass as small specimens of *Staurodoris pustulata* Abraham; the pustules on the back are similarly placed and the colours are somewhat the same.

MADRELLA SANGUINEA (Angas)

Janus sanguineus Angas, 1864, *Journ. de Conch.*, 12, p. 63, pl. 6, f. 5.

Up to 10 mm, long, 3 mm. wide. Aelidiform; head expanded into a semi-circular veil in front, large; foot broad, with 3 grooves in front, tapering sharply behind. Mantle lachrymose in shape, surrounded by 3 or more rows of non-caducous branchial papillae. Papillae fusiform; outer row short and stout; inner row long, some papillae crossing over the dorsum. Rhinophores claviform, upper half surrounded by a single row of closely-set papillae. The whole animal, particularly the papillae, exudes a bright red fluid when irritated. General body-colour blood red as the specific name implies. Radula formula 36 x 1.1.1.

Locality: Torquay (1 spec. Mar., 1956); Breamlea (1 spec. Oct., 1956).

Station: Rare, under stones and crawling on seaweed in rock pools, low tide.

Remarks: This species is also recorded from Japan.

MELIBE AUSTRALIS Angas
(Pl. I, fig. 12)

Melibaea australis Angas, 1864, *Journ. de Conch.*, 12, p. 62, pl. 6, f. 2.

Very small, up to 15 mm. in length. Head expanded into a very large, trumpet-like veil or hood; inner margin lined with a single row of short, stout cirri or tendrils. Rhinophores on long, trumpet-like stalks arising from the hood. Cerata in 4 pairs on back; upper flat end of each pitted with small holes. Dendritic papillae thickly set on median part of back between cerata. Whole body except sole minutely granular. Foot very narrow, sharply pointed in front and behind. Liver-diverticula follicular. Body-colour dirty yellow-cream, cerata dark internally from liver.

Locality: Torquay (2 spec. Oct.-Nov., 1956); Queenscliff (9 spec., Nov., 1956).

Station: Occasionally common, crawling on brown seaweed or under stones.

Remarks: Egg ring small, an incomplete ellipse, diameter 4.5 mm. and 3 mm., depth 3 mm.; eggs white, in a clear gelatinous mass. This species is apparently rare in New South Wales.

MELIBE PELLUCIDA, sp. nov.

(Pl. III, fig. 5-7)

Small, very elongate, length up to 40 mm. Hood very large, notched dorsally and ventrally; cirri arranged on the hood margin in one row, rather long and thin. Cerata in 6 pairs, not easily falling off. No dentritic papillae. Cerata large, about one-quarter of body-length, rather narrow for length, apices pointed; everywhere covered with sharp-pointed tubicles. Foot extremely narrow, rounded in front, pointed behind. Rhinophores large, on very long stalks surmounted by a cup-like shield; between shield and base of stalk, posteriorly, is a delicate but voluminous veil-like membrane, edge of which is minutely serrated; clavus of rhinophores small, with 5-7 laminae. Liver-diverticula flocculent. General body-colour transparent pale 'yellow or orange, longitudinally lined with bright yellow streaks, everywhere flecked with minute red dashes. Apices of first pair of cerata usually red.

Locality: Torquay (6 spec. Nov.-Dec., 1956).

Station: Uncommon, under stones between tides.

Remarks: In an aquarium, this species is very active, swimming from the bottom to the surface with a graceful exhibition of twisting and turning. The animal swims on its side, starting off by lifting its head and tail until they nearly touch; then it thrusts downwards and so lifts its body. This is quickly repeated again and again till the animal has reached the surface or has touched something and adhered to it. From *M. australis* Angas this species differs in being larger, with a greater number of cerata, and lack of dentritic papillae on dorsal surface.

HERVIA ORNATO (Angas)

Flabellina ornata Angas, 1864, *Journ. de Conch.*, 12, p. 67, pl. 6, f. 7.

Length up to 22 mm. Rhinophores with 9 rings; cephalic tentacles linear. Body shape acolidiform. Branchial papillae in 9-10 groups on either side, in a double row in the first three groups. There are 18 papillae in the first group, about 15 in the second, about 12 in the third to fifth, thus decreasing in number backwards; on horseshoes in the anterior groups, the rest on mere oblique rows. Penis large, transparent light blue, narrow at base, becoming very broad and tapering slightly to a rounded end, on which is a nipple-like protuberance; a minute yellow tube passes through the penis to the nipple. Branchial papillae rather stout, pointed, very dark internally, extenally flecked with orange, red, brown, yellow, green and blue. Foot corners broadly tentaculiform. Body-colour usually orange or yellow flecked with fawn or white. The multi-coloured papillae are very distinctive.

Locality: Torquay; Breamlea; Blanket Bay; Sutherlands Bay, Phillip Island.

Station: Common, under stones and crawling on weed between tides.

Remarks: Egg ring consists of 4 flat concentric rings of pink eggs, 8 mm. diameter. From the following species, this is larger, with a greater number of branchial papillae; the rhinophores are annular in form and the colouring is brighter.

This species and the next, although originally described as *Flabellina* Cuvier, 1830, are here placed in *Hervia* Bergh, 1871, as the positioning of the branchial papillae are better suited for this genus

HERVIA NEWCOMBI (Angas)

Flabellina newcombi Angas, 1864, *Journ. de Conch.*, 12, p. 68, pl. 6, f. 8.

Length up to 15 mm. Rhinophores with 4 encircling rings of nodular papillae; cephalic tentacles stouter than the above species. Branchial papillae in 4-5 groups on either side, first 2 groups set on horseshoes, rest on oblique rows. About 12 papillae in the first group, 10 in the second. Branchial papillae stout, apices rounded; extremely dark internally (greenish-black), externally devoid of colour. Foot corners narrowly tentaculiform. Body-colour pale green maculated with cream.

Locality: Portarlington, Breamlea, Flinders.

Station: Rather rare, under stones at low tide.

(?) HERVIA PEONICIA, sp. nov.

(Pl. II, fig. 7-10)

Length up to 23 mm., extremely narrow. Rhinophores smooth on leading edge, with 8-12 rows of small nodules on the posterior edge; cephalic tentacles extremely long and narrow. Branchial papillae in 7 groups, four papillae in the first and second, 3 in the third to fifth, 2 in the sixth and one in the seventh. In a single row in each group. Gental oriface below posterior part of first right group. Papillae long, slender, apices, acutely pointed; nearly transparent. Foot-corners very narrowly tentaculiform; foot narrow, grooved. Body-colour pale mauve, with two bright purple patches in front of the rhinophores. Rhinophore base mauve, nodules light green, apex yellow. Papillae bright transparent red tipped with yellow.

Locality: Breamlea (type locality, 4 spec. Oct., 1956); Portarlington (5 spec. Oct., 1956).

Station: Occasionally common; crawling on seaweed in pools at Breamlea; under stones between tide levels at Portarlington.

Remarks: From *H. onata* and *H. newcombi*, this species differs in being very narrow, the small number of slender papillae and the arrangement of the papillae along either side Provisionally placed in *Hervia* till a better genus can be found.

In conclusion, I wish to thank Miss J. H. Macpherson, Miss Joyce Allan, and Mr. B. C. Cotton and others for assistance with material, literature, notes, etc.

REFERENCES

Allan, J., 1932. *Aust. Zool.*, Vol. 7, pt. 6.
———, 1932-1933. *Rec. Aust. Mus.*, Vol. 18, Nos. 6-9.
———, 1947. *Rec. Aust. Mus.*, Vol. 21, No. 8.
Angas, G. F., 1864. *Journ. de Conch.*, Vol. 12.
Baba, K., 1949. *Opisthobranchia of Sagami Bay* (Tokyo).
———, 1955. *Opisthobranchia of Sagami Bay* (Tokyo).
Basedow, H., & Hedley, C., 1905. *Trans. Roy. Soc. S. Aust.*
Bergh, R., 1871-1905, *Reis. im. Arch. der Phil.: Malacologische Untersuchungen.*
———, 1884. *Report Sci. Res.*, "Challenger," *Zool.*, Vol. 10.
Hedley, C., 1905. *Proc. Linn. Soc., N.S.W.* Vol. 30, p. 4.
———, 1923. *Proc. Linn. Soc., N.S.W.* Vol. 48, pt. 3.

EXPLANATION OF PLATES

Plate I.

1. *Praegliscita chrysoderma* (Angas)—dorsal view with branchiae closed.
2. ,, ,, ,, —ventral view of anterior part.
3. ,, ,, ,, —half row of radula.
4. ,, ,, ,, —rhinophore.
5. ,, ,, ,, —detail of open branchiae.
6. *Thordisa sabulosa*, sp. nov. —dorsal view.
7. ,, ,, ,, —ventral view of anterior part.
8. ,, ,, ,, —half row of radula.
9. ,, ,, ,, —rhinophore.
10. *Glossodoris alternata*, sp. nov. —dorsal view.
11. ,, ,, ,, —ventral view.
12. *Melibe australis* Angas —dorsal view

—Del. R. Burn.

Plate II.

1. *Euphurus multidigitalis*, sp. nov. —dorsal view.
2. ,, ,, ,, —ventral view.
3. ,, ,, ,, —detail of pallial ridge.
4. ,, ,, ,, —rhinophore.
5. ,, ,, ,, —detail of pustules on dorsum.
6. ,, ,, ,, —branchial plumes.
7. (?) *Hervia peonicia*, sp. nov. —dorsal view.
8. ,, ,, ,, ,, —ventral view.
9. ,, ,, ,, ,, —rhinophore.
10. ,, ,, ,, ,, —branchial papillae first right group.
11. *Glossodoris tasmaniensis* (Bergh)—dorsal view.
12. ,, ,, ,, —ventral view.
13. *Nembrotha arnoldi*, sp. nov. —right lateral view.
14. ,, ,, ,, —ventral view of anterior part.

—Del. R. Burn.

Plate III.

1. *Glossodoris perplexa*, sp. nov. —dorsal aspect.
2. *Glossodoris haliclona*, sp. nov. —dorsal aspect.
3. *Dendrodoris albopurpura*, sp. nov.—dorsal aspect.
4. *Glossodoris victoriae*, sp. nov. —dorsal aspect.
5. *Melibe pellucida, sp. nov.* —right lateral aspect.
6. ,, ,, ,, —detail of rhinophore.
7. ,, ,, ,, —detail of cerata.
8. *Cyerce nigra pallens*, subsp. nov. —upper side of lamina.
9. ,, ,, ,, ,, ,, —reverse side of lamina.
10. ,, ,, ,, ,, ,, —liver ramifications.
11. ,, ,, ,, ,, ,, —ventral view of anterior part.
12. *Dendrodoris albopurpura*, sp. nov.—detail of rhinophore.

—Del. R. Burn.

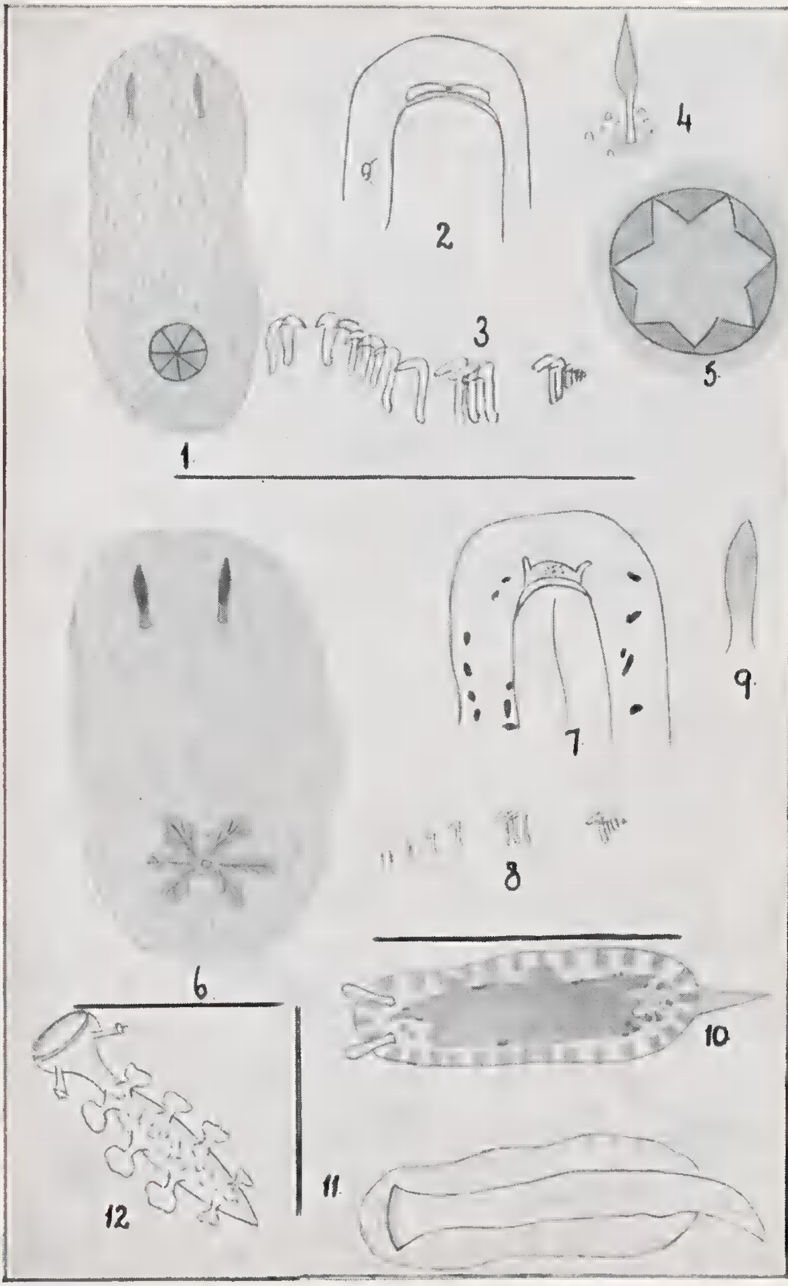

Plate 1.

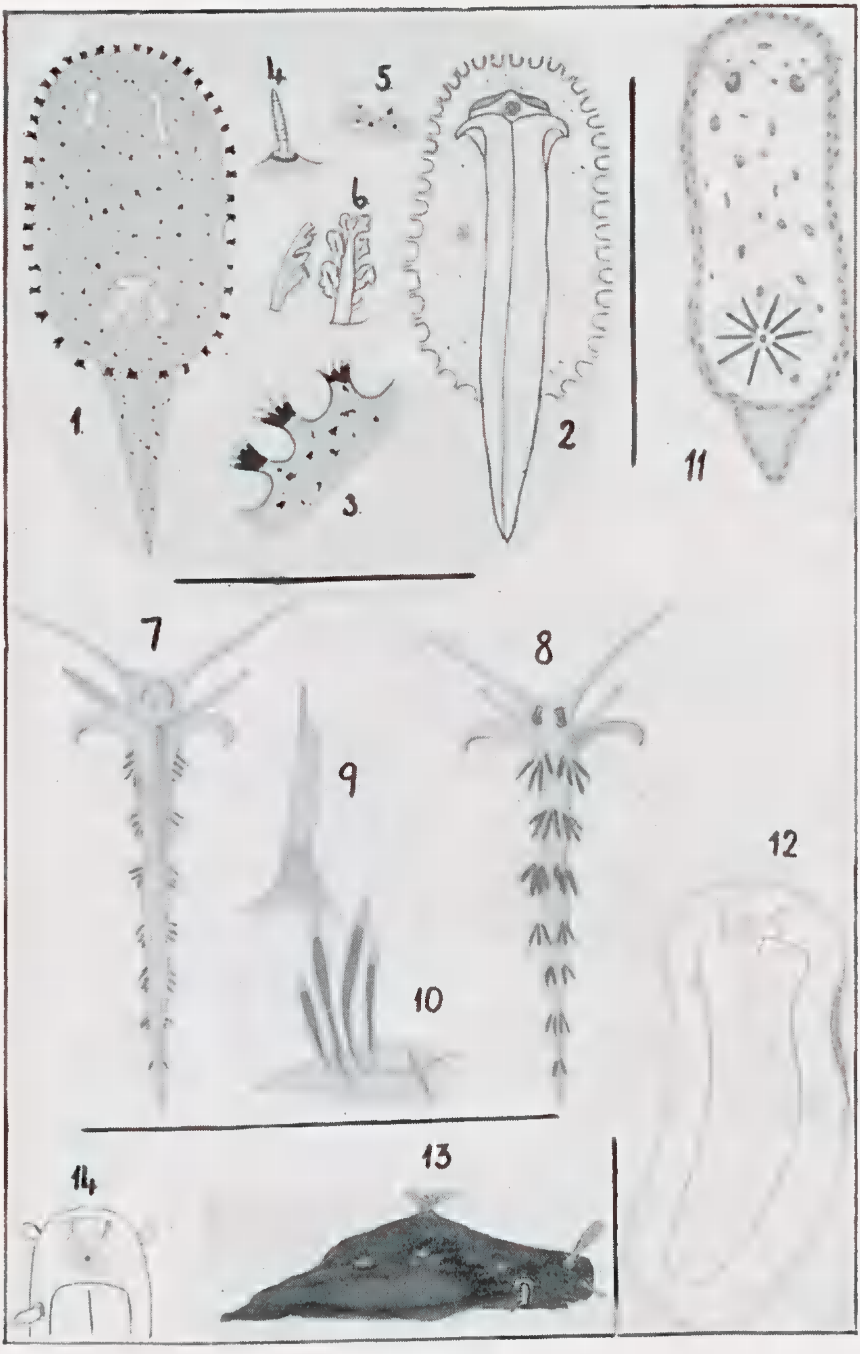

Plate 2.

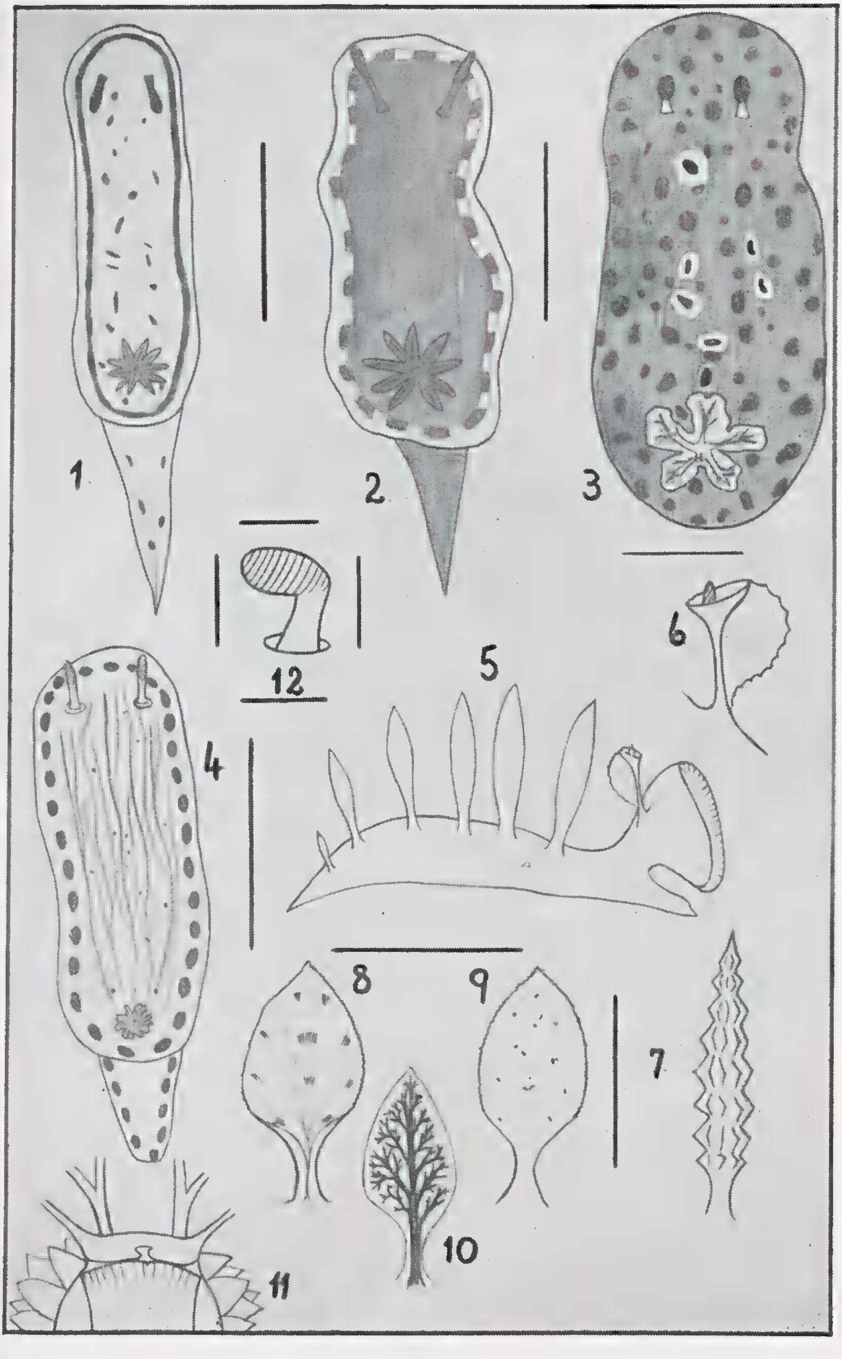

Plate 3.

A NEW SPECIES OF THE VOLUTIDAE FROM NORTH AUSTRALIA

By PROF. J. M. OSTERGAARD† and RAY SUMMERS*

AULICINA PERRYI, sp. nov.

Description: Shell ovately oblong, with rather prominent spire, obtuse at apex and minutely noduled, the nodules increasing in size anteriorly, becoming small sharply-pointed spines on the penult whorl. On the body whorl the spines become prominent, broad at their bases, erect, and very sharp. Whorls smooth, concave on posterior part, but angled where they bear the spines. Columella four-plated, aperture oblong, lip thin, with a narrow zone of pale brown within aperture near margin. Colour of shell white superimposed on a pale carmine ground, with blotches of pale brown, which form an undulating band across the spines of the body whorl. Two large transversely oblong spots of same colour are present near anterior end of body whorl. Brown areas occur on the spire, becoming gradually obscure at the apex. Aperture and columella white.

Size: Length of shell 47 mm., length of aperture 33 mm.

Locality: Queensland, Aust., on Westaria Reef in the Capricorn Group.

Remarks: The holotype is in the collection of Raymond H. Summers, Petaluma, California, U.S.A. The paratype is in the collection of Arthur J. Nash, Gladstone, Queensland, Australia, and an immature specimen is in the collection of Roy Perry, Gladstone, Queensland, Australia, the gentleman who collected all three specimens and generously presented the co-author with a specimen. According to observations made by the discoverer, Roy Perry, after whom this shell is named, the mantle of the animal was of a "greater percentage of yellow in its outer fringe than is present in *Voluta pulchra* Sowerby." Three known specimens were collected alive in March, 1953. This species seems to be most nearly related to V. *pulchra* Sowerby, with which it agrees quite closely in form and sculpturing, but from which it deviates greatly in colour pattern, lacking the ornamental design of V. *pulchra*. Perry and Nash reside in the area where the specimens were taken and have collected for a number of years without seeing any other examples of the new species.

† Atherton, Calif., U.S.A. * Petaluma, Calif., U.S.A.

Aulicina Perryi, sp. nov.

VALIDITY OF THE GENUS EXOHALIOTIS

By ROBERT R. TALMADGE*

Since the description of the Genus *Haliotis* by Linnaeus in the tenth edition of the *Systema Naturae* in 1758, there have been a number of proposed subdivisions. De Montfort, 1810, noting that no type had been designated by Linnaeus, utilized the Linnaean species *Haliotis asinina* as the type. As far as could be determined, all of the names covering the divisions of the genus have been based upon shell features alone, with little work on the anatomy. The only works noted on the soft parts dealt chiefly with biological projects, with little concerning the taxonomy.

The writer, while engaged in a systematic study of this marine family, had utilized the soft parts in checking the status of various species and subspecies. This led to the accumulation of the soft parts of a number of named genera and subgenera. The portion of the animal found most useful for rapid and accurate separation was the fleshy epipode encircling the muscular foot of the animal.

In most Haliotids, this epipode was of various widths and concave, with an upper and lower rim. These rims might be serrate, palmate, lobed, and with various forms of projections (processes). The concave portion might be smooth, granular papilose, papilae on papilae, or even processed with either single or multibranching projections. Thus it was easy to note the species separations, as seldom did two species have similar forms of the epipode. If so, the shells were distinct and separation carried out by that means. Thus, one worked with a combination of shell and animal.

It was rather interesting to find that a more or less common Australian species had an epipode that was separable from any other species examined. The South Australian and western Victorian species, *Haliotis cyclobates* Peron, 1816, had a narrow or singular rim-like epipode that was frilled with fine, more or less even processes. Perhaps a better description and comparison might be stated thus. Most of the *Haliotis* have a double-rimmed epipode with a concave area between the rims; whereas in the *Haliotis cyclobates* this is restricted to a single rim, without the concave area.

Cotton and Godfrey, in the *South Australian Naturalist*, Vol. XV, p. 16, Nov., 1933, proposed the subgenus *Exohaliotis*, with the *Haliotis cyclobates* as the type. Their diagnosis is as follows: "*Exohaliotis* (subgen. nov) shell subcircular, very convex, spire subcentral and comparatively extremely elevated; spirally lirate and radiately folded. Type *H. cyclobates* Peron." On pages 19 and 20 of this same publication further discussion as to size, range in depth and area, and coloration was carried out. Kangaroo Island was given as the type locality.

With such distinctive shell features found in no other *Haliotis*, and with animal that is also separable from any other *Haliotis*, it appears that the status of a full genus for the *Exohaliotis* is validated.

Appreciation for anatomical parts is given to Mr. George Pattison of Glenelg, South Australia, and to Miss Macpherson of the National Museum of Victoria, in Melbourne.

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* Willow Creek, Calif., U.S.A.

BOTHRIEMBRYON BARRETTI DISCARDS ITS EPIPHRAGM

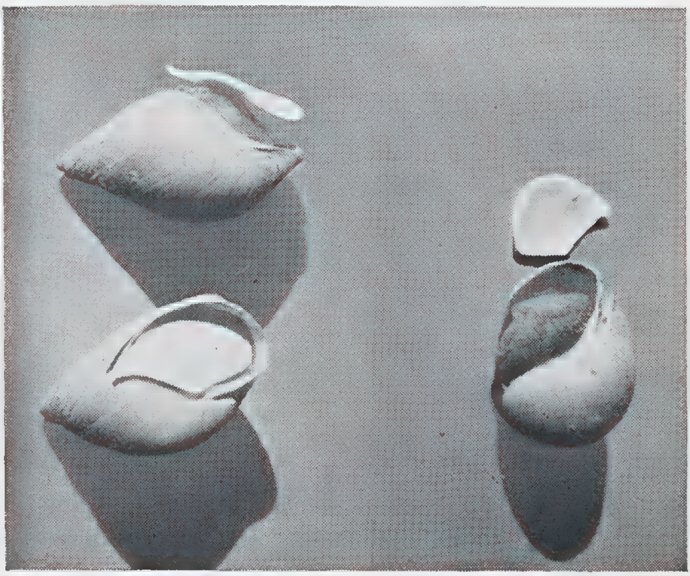
BOTHRIEMBRYON BARRETTI Iredale 1930

By THELMA HARTLEY*

This one inch long native Australian land snail belongs to the peculiar family Bothriembryontidae so well developed in South-Western Australia. It is one of over thirty species of the genus, and it is named after the great Victorian Naturalist, Charles Barrett. A few living and dead specimens were taken by myself on a recent expedition to Western Australia, between Madura and Cocklebiddy in the Nullabor Plains, on 18th September, 1956.

An interesting fact is that I found operculum-like objects of thin white calcerous structure, literally covering the ground for about three feet underneath nearly every bush. The living snails had the "operculum" stuck to the foot on an area no larger than a pin's head, and it moved in and out with the foot almost like a true operculum. There are no operculate land snails in Southern Australia, so that the white objects proved to be epiphragms about to be and already dispensed with.

Colour slides were taken of this extraordinary occurrence and black and white photographs made from them of the shells and epiphragm are reproduced here.



Bothriembryon barretti Iredale, with epiphragm.
Nullabor Plains, 18th Sept., 1956.

* Melbourne, Australia.

EXISTING BEDS OF THE BIVALVE ANADARA TRAPEZIA Deshayes 1840 IN WESTERNPORT BAY, VICTORIA

By R. J. PLANT*

One of the shells to be found in great quantity lying dead on the more sheltered beaches of South-Eastern Australia is that of the Ark *Anadara trapezia.* The shell is thick and trapeziform, with radiating ribs about twenty-six in number, and has a dark brown rather scaly periostracum. The hinge bears a number of small ventral teeth in an unbroken series. Fully matured specimens reach three inches in length.

Although quite common in tidal flats from southern Queensland to New South Wales, in Victoria only a few living specimens have been taken over the past few years. In South Australia it is subfossil, having died out in the Middle Recent times. Therefore, it is interesting to record the location of some quite extensive beds near Rhyll, a small fishing village on Phillip Island, in Westernport Bay.

During the year 1956 a regular scrutiny of the tide lines in this locality, where dead valves are found in great quantity, produced one living specimen, and from this evidence and careful questioning of a reliable local fisherman, an attempt was planned to find beds of the *Anadara trapezia* which it was thought could still exist in the bay. The best indication of possible location was a statement by the fisherman that he had felt the contact of heavy shells against his legs when hauling nets on certain parts of the mud flats, and of course this narrowed the search down considerably, as the mud flats in this area cover many square miles and the task of searching them would have been very slow.

Conditions for searching are very difficult, as the mud is thick and black, and varies from a depth of thirty inches to four feet in a matter of yards. At first only a few living specimens were found, but further work resulted in the discovery of the first of the large beds, which appeared to cover about half an acre. Since this observation, much larger beds have been found, and they would cover much larger areas. These molluscs do not appear to keep company with any other molluscs, and they live close together as the dominant species on the beds. Not more than a few inches separate one from the other, the whole bed of them surfaces quite regularly at low tide, but may be as far as 18 inches down in the mud at times.

As the most logical explanation for the sudden disappearance of the *Anadara trapezia* from southern Australian waters would be a sudden variation of temperature, it is well to note how sheltered these beds are from the colder ocean waters, and, although further south than the neighbouring State of South Australia, the waters of this bay are comparatively warm. The depth of this section of Westernport is never greater than 2 fathoms, and an average rise and fall of tide from 7 to 8 feet keeps the average temperature over the year at approximately 58 degrees. During the coldest of winter months this does not fall below 54 degrees and reaches 69 degrees at times during the summer period.

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* Cowes, Port Phillip Island, Victoria, Australia.

The beds have remained undisturbed for probably over a century, as they are not taken by the local fisherman for bait or any other purpose. There is, however, evidence that aborigines on Phillip Island did take them for food, as some of the cooking middens still show remains of fire-blackened valves. There is not likely to be any interest taken in the *Anadara trapezia* because of the red blood of the animal, which discourages any persons who may have thoughts of taking them for food, as the appearance is not attractive.

The interesting sequel to the location of these beds is that an attempt is at present being made to re-introduce the living mollusc into part of South Australia. According to information available from that State, it is evident that at one time large beds of *Anadara trapezia* flourished at Port Wakefield, near Adelaide (Cotton 1957), and therefore it was decided to make an attempt to transfer some living specimens from Westernport to Adelaide (a distance of some 600 miles). Their passage was carefully arranged, and some 50 living specimens of various size and age were selected and despatched by air to that city, where they arrived less than 24 hours after being taken from the sea at Rhyll. Some of these specimens were handed to the University of Adelaide, and the remainder were placed in the sea in suitable conditions, near Semaphore, in the Gulf St. Vincent, where their career is being watched with interest.

As conditions and water temperatures are similar to those in Westernport Bay, it is hoped that the experiment may be successful; however, it will be some months before any indication can be given as to whether this will be so.

Existing beds of the Bivalve *Anadara trapezia* (Deshayes 1840) in Westernport Bay, Vic.

A SPECIES OF FERUSSACIA IN SOUTH AUSTRALIA

By L. A. W. C. VENMANS,* Ph.D.

Since Quoy and Gaimard, in 1824, published the first record of European slugs (*Limax maurus* = *Milax gagates* and *Limax megalodontes* = *Limax flavus*) in South Australia, several authors have recorded new intruders.

In his Presidential Address, delivered at the annual meeting of the Malacological Society of London, 9th February, 1952, Dr. H. E. Quick gave a survey of the literature on that subject and published a list of fifteen western European land molluscs introduced into Australia and Tasmania.

In 1954 B. C. Cotton published his Catalogue of the introduced snails and slugs in Australia, and mentions 35 species, most of which inhabit the Mediterranean and western European areas.

Dr. H. E. Quick kindly sent me some specimens of one of these adventive molluscs collected in the summer of 1953 by Mr. B. C. Cotton, who, later on, was good enough to send me some more material.

The species was first seen in great numbers during July and August of that year at Verdale Avenue, Linden Park, an eastern suburb of Adelaide, within four miles of the centre of the city. They were in very damp places, under the bricks, old cement bags, etc., on a block of land on which the foundations and walls of a new house had been built. The animals were active, apparently prolific, and, if disturbed, rapidly moved from light to seclusion.

In January of the same year the undergrowth of the building block was burnt off; only a few small olive trees, so common in the district, where they were originally introduced some hundred years ago by early colonists, probably from Italy, were growing there, and at the time of the find a thick growth of grass covered the ground without any unusual weed. No clue could be found as to how the snails came there. Mr. Cotton assures me that only locally-made cement, bricks, steel window frames and no imported materials have been brought to the blocks, so that it seems most likely that some specimens of this small species, like several other Mediterranean species, which have been imported into Australia from time to time, were introduced with trees or plants. If they were imported with the olive trees growing there, they must have lived and multiplied on a quarter of an acre since early times, and been overlooked until the summer of 1953, which possibility is hardly acceptable. There are no records of the species from other localities in Australia, and since then the snails disappeared from the scene as suddenly as they turned up.

It is quite certain that the specimens from South Australia belong to the genus *Ferussacia* Risso, 1826, *sensu stricto*. According to Cotton (1954, p. 185), H. E. Quick, after examining some specimens of the lot, came to the same conclusion, and Cotton (1954, p. 184) described the species under the name of *Ferussacia folliculus* (Gronovius, 1781).

I am, however, not convinced that the specimens, a number of which are listed in my collection under No. 7372, belong to the true *Ferussacia folliculus* (Gron.) because they seem to differ from a number of specimens described as such in many respects.

Numerous forms of the genus *Ferussacia* Risso, 1826, are known from the Mediterranean area, as well as from the European and African main-

* Moergestal, Netherlands.

lands, and from the Canaries, Madeira and other western Mediterranean islands. Thiele (1931, pp. 547 and 548) divided the genus into five subgenera, and the subgenus *Ferussacia* s.s., to which our specimens belong, into two sections: *Ferussacia* s.s., of which the type species is *Ferussacia gronoviana* Risso, and of which representatives are indigenous in the Mediterranean area and on the Canary Islands, and the section *Pegea* Risso, 1826, which is limited to North Africa only, and of which the type species is *Ferussacia* (Pegea) *carnea* (Risso).

Because of the form of the shell, the shape of the aperture and the armament of the columella, the South Australian specimens have to be classed in the first-named section, to which also the species *Ferussacia folliculus* (Gron.) belongs.

Even of the section *Ferussacia* s.s. many forms have been described, but there is, however, such a great variability in shape and measurements of the shells, even in the same species, that it seems for the present impossible to make out with reliable certainty how many really distinct species there are.

Nevill (1880) pointed out this fact, and after him Watson (1928), Odhner (1931), Soos (1933), Wachtler (1935) and several other authors came to the same conclusion.

To form an idea of the variability of the representatives of the genus I give here a list of some allied species with their mean measurements and indices, as mentioned by some of the principal authors.

	Height of Shell in mm.	Maj. Diam. of Shell in mm.	Index
F. folliculus (Germain, 1930)	8–9	2.75–3	33–34
(Odhner, 1931)	10.5	3.6	34
	10.0	3.7	37
	9.0	3.0	33
	9.0	3.6	40
F. vescoi (Soos, 1933)	8.4	3.2	38
	9.1	3.3	36
	10.1	3.6	36
(Germaine, 1930)	9.0	4.0	44
F. abromia (Germaine, 1930)	11.0	4.0	36
(Bourguignat, 1864)	11.0	3.5	32
F. amblya (Nevill, 1880)	8.5	4.0	47
F. barclayi (Pfeiffer, 1855)	9.0	4.0	44
(Pilsbry, 1908)	8.6	3.5	41
	10.0	4.0	40
	8.3	3.5	42
F. gronoviana (Germain, 1930)	7.0	3.25	46
(Nevill, 1880)	10.0	3.75	38
	9.0	3.75	42
F. gronoviana f. *subamblya* (Nevill, 1880)	8.25	3.3	40
F. gronoviana f. *subfolliculus* (Nevill, 1880)	9.0	3.5	39
F. gronoviana f. *subforbesi* (Nevill, 1880)	8.25	3.25	39
	8.5	3.5	41
	7.75	3.0	39

The measurements of the South Australian specimens are as follows:—

Height in mm.	Maj. Diam. in mm.	Number of Whorls	Index
9.0	3.7	$5\frac{3}{4}$	41
9.0	3.7	$5\frac{3}{4}$	41
9.0	3.6	$5\frac{3}{4}$	40
8.6	3.8	$5\frac{3}{4}$	44
8.6	3.7	$5\frac{3}{4}$	43

On account of the circumstances mentioned above, and of the great uncertainty concerning the boundaries between the diverse species, varieties and races, it is for the present quite impracticable even to make an attempt to come to a conclusion regarding the identity of the very few specimens available from South Australia.

Though this is also the opinion of Dr. E. H. Madge, Director of the Victoria Hospital at Quatre Bornes, Mauritius, who kindly compared my specimens with as many lots of *Ferussacia* as he could find in the British Museum in London, and also of Dr. G. Ranson, Vice-Director of the Malacological Museum in Paris, who compared them with the lots of *Ferussacia* in the Paris Museum, I will refer to the following facts:—

In the middle of the nineteenth century Sir D. Barclay found in the Isle of France (Mauritius) a species, which Pfeiffer (1855), in honour of the discoverer, described under the name *Spiraxis barclayi.*

Nevill also found the species even before 1870, for Semper mentions in that part of his *Reisen im Archipel der Philippinen,* which was published in that year, that he received from Nevill a shell under the name of *Glandina vericulata* Benson, which Pilsbry (1908, p. 233) asserts to be a synonym of *Ferussacia barclayi.* Semper, however, did not say where the specimen was found, but he gives a not very detailed description of the jaw and the radula, without figuring the shell or the described organs.

In visiting Mauritius in 1878, Nevill came again upon specimens of the same species, and even found a sinistral example. According to Pilsbry (1908, p. 233), who first figured the species, it appeared to belong to the genus *Ferussacia,* and was probably an introduction from southern France. It differs from *Ferussacia folliculus* (Gron.) (i) by its slightly more ventricose last whorl, and, in accordance, by its somewhat wider aperture. Pilsbry's figures 66, 67 and 70 agree very well with the majority of our specimens.

It is uncertain whether, at present, the species is still living on Mauritius. Dr. Madge, who made extensive collections on the island, assures me that he has never found it. He compared my specimens also with those found by Nevill on Mauritius and at present in the British Museum, and came to the conclusion that at least four specimens of my lot agree very well with *Glandina vericulata* = *Ferussacia barclayi.* The other specimens agree pretty well with specimens from Spain labelled by Tomlin as *Ferussacia vescoi* (Bourguignat). The Australian specimens are somewhat more bulging

(i) Germain (1930, p. 322) wrongly changed the name to *Ferussacia follicula.* This is incorrect, because *folliculus* is a substantive signifying "a little grain," and not a declinable adjective.

than is generally the case in *Ferussacia folliculus*, and the columella is internally twisted as in *Ferussacia vescoi* and *F. barclayi.*

Mr. Ranson agrees with Dr. Madge as to the first four specimens, but feels sure that the other ones are true *Ferussacia folliculus* (Gron.), not *Ferussacia* (Bourg.), which he thinks to be a true species and not a variety of *F. folliculus.* Therefore, it is quite possible that our specimens have not been introduced into South Australia directly from the Mediterranean area, but via the intermediate station of Mauritius.

Even after a thorough anatomical investigation of a number of species neither Moquin-Tandon (1855), who studied the anatomy of *Ferussacia folliculus* (Gron.), nor Godwin Austen (1880), who investigated anatomically *F. gronoviana* Risso, nor Watson (1928), who studied the anatomy of *F. folliculus* (Gron.) and *F. oranenisis* (Bgt.), nor Soos (1933), who dissected *F. vescoi* (Bgt.), nor Wachtler (1935), who investigated the anatomy of *F. folliculus* (Gron.), *F. reissi* (Mart.), *F. lanzarotensis* (Mouss.) and *F. vescoi* (Bgt.) could come with certainty to a reliable conclusion concerning sharp differences between them, though sometimes slight differences between some organs were established.

Probably many of what hitherto have been considered separate species will finally appear to be only ecological forms of one of two true species.

Our final conclusions must be, for the present, that, without a very extended taxonomical, anatomical, biological and ecological comparative investigation, it is as yet impossible to settle the question entirely.

Nevertheless, it seems to me subservient to later investigations, if I record here some of my experiences in dissecting the animals from South Australia.

According to some authors, the skin of the various species of *Ferussacia* seems to have a specific coloration, varying from greyish to yellow or green. However, as they had been in alcohol so long, nothing could be seen of this external coloration or of the pigmentation of the internal organs in my Australian specimens.

As is generally the case in the sub-family, *Ferussaciinae*, the relatively long and small foot shows a well-marked pedal fringe as well as a conspicuous suprapedal grove, and a well-developed mucous pore at a short distance from the caudal end.

The jaw (Fig. 1) is aulocognath, very thin and elastic, and of a yellowish colour. It has a number of narrow, smooth longitudinal folds or ribs, which converge posteriorly, and of which the central ones (about eight) touch each other on an imaginary median line. In the literature I could not find any special note concerning this peculiar course of the folds, though Watson (1928) figures converging striae to a certain extent for *F. oranensis*, and also to a small degree for *F. folliculus.*

According to Watson (1928), the jaw of *F. oranensis* has 48, and of *F. folliculus* only 42 folds. Wachtler (1935), however, counted 48-69 folds in the jaw of *F. folliculus*, whereas he found in *F. vescoi* 48-52, and in *F. reissi* 44 folds. Soos (1933) found in his specimens from the Maltese Islands, which he considered to belong to *F. vescoi*, and of which he states

that the jaw is exactly as in *F. gronoviana,* about 40-50 folds. In our specimens I counted a number of 48, 50 and 64 folds.

Watson (1928) gives for *F. folliculus* a breadth of 0.75 mm., and for *F. oranensis* a breadth of 0.65 mm. The breadth of the jaw in our specimens is about 0.90 mm., and the height in the middle part about 0.30 mm.

I have investigated the radulae of seven specimens, and found the following details:—

Transverse Rows	Formula	Length in mm.	Breadth in mm.
77	25–12–1–12–25	1.6	0.6
88	21–12–1–12–21	1.7	0.5
87	25–12–1–12–25	1.6	0.7
90	26–12–1–12–26	1.6	0.7
87	26–12–1–12–26	1.6	0.6
80	25–12–1–12–25	1.5	0.6
85	25–12–1–12–25	1.7	0.7

The course of the transverse rows is shown in fig. 2.

The central tooth is about the same length as the adjacent teeth on each side of it, but very much narrower, the length being about 0.025 mm. and the breadth about 0.007. At its front edge it bears three small blunt cusps, of which the middle one is slightly longer than the side ones.

The first twelve teeth on either side of the central tooth have well-developed bases provided with three more or less sharply-pointed cusps, of which the middle one is very powerful and much longer than the adjacent side cusps. Towards the outer edges of the radula they diminish in length and breadth; the bases gradually become comparatively more powerful, whereas the cusps diminish in size, the mesocones more rapidly than the side cusps. In the first teeth on either side of the central tooth the middle cusp is about four times as long as the side cusps, in the seventh lateral teeth the mesocone is still three times as long as the side cusps, whereas in the twelfth lateral teeth the ratio is not more than 2: 1.

From about the thirteenth tooth on each side of the rhachis there is a row of very small marginalia, which continue to diminish in size gradually towards the outer edges of the radula, and, apart from the very minute projecting cusps at the base, have the form of small rectangles closely placed side by side.

The central and lateral teeth of the successive transverse rows overlap each other, but towards the outer edges of the radula the overlapping gradually diminishes, so that in the outermost parts the marginals of the successive rows are fully detached.

The genitalia (figs. 4-7) are quite simple.

The albumen gland (about 1.5 mm. long) is rather large at its anterior end and narrowing distally; the hermaphrodite gland consists of a number of small oblong follicles opening into the very narrow hermaphroditic duct, which is at first straight and then slightly convolute in its distal third.

The rather long female left side of the spermoviduct (about 5 mm.) is swollen in most of the specimens, and contains a number of very little

eggs, which increase in size towards the front. The male right side is furnished with a comparatively small, though well developed, prostate gland consisting of a number of single glands.

The vas deferens leaves the spermoviduct at about the same level as the anterior end of the receptacular duct, so that the free oviduct is extremely short. The unbranched receptacular duct is rather broad and long (about 3.5 mm.) and arises from a well-developed oval spermatheca; its anterior third shows a conspicuous widening in the middle.

The vagina is about 1.5 mm. in length and slightly narrowing towards the anterior end, where it passes into a genital atrium of moderate length and diameter.

The vas deferens is long (about 4.5–5 mm.) and narrow throughout its length, though slightly broadening apically; it winds around the vagina and enters the apical part of the penis just below or at the insertion of the penial retractor muscle, which is simple and attached to the dorsal body wall.

The penis is broad and comparatively short, its length being only about 1.5 mm.; it consists of a cylindrical main penis, which is somewhat narrowed, or even strangulated in the middle part, and a small muscular lateral penial appendage. Though in the specimen of fig.5 the penial appendage is directed backwards and in that of fig. 6 it is also directed backwards in some degree, I think that the original direction of the appendage, if fully extended, is forwards. The specimen drawn in figs. 4 and 7 appeared to show the fully extended penial appendage, and this is directed forwards. In the specimens drawn in figs. 5 and 6 the appendage is more or less contracted, and in consequence assumes a more backward position. The specimen of *Ferussacia folliculus* examined by Watson (1928) and drawn in his fig. 10 shows the penial appendage directed sideways and partially invaginated, but I should not be astonished if that peculiar position is due to contraction as well.

REFERENCES

Pfeiffer, L., 1855. Descriptions of Forty-seven New Species of Helicea. from the Collection of H. Cuming, Esq., *Proc. Zool. Soc., Lond.*, 23, pp. 91-101.

Bourguignat, J. R., 1864. Malacologie de l'Algerie, histoire naturelle des animaux Mollusques terrestres et fluviatiles recueillis jusqu'a ce jour dans nos possessions du nord de l'Afrique. Paris.

Semper, C., 1870. Reisen im Archipel der Philippinen. Landmollusken, 3.

Watson, B., 1875. On the Generic Peculiarities of the distinctively Madeiran Achatinae of Lowe. *Proc. Zool. Soc. Lond.*, pp. 677-680.

Watson, B., 1877. Some notes on the Madeiran Mollusk identified by the Rev. R. T. Lowe as *Achatina folliculus* Gron. *Proc. Zool. Soc., Lond.*, pp. 333-334.

Nevill, G., 1880. On the Land-Shells, extinct and living, of the Neighbourhood of Menton (Alpes Maritimes), with Descriptions of the new Genus and of several new Species. *Proc. Zool. Soc., Lond.*, pp. 94-142, pl. XIII and XIV.

Godwin-Austen, H. H., 1880. On the Anatomy of *Ferussacia gronoviana* Risso, from Mentone. Concluding with a Note of the Classification of the Genus and its Allies by Geoffrey Nevill. *Proc. Zool. Soc., Lond.*, pp. 662-666, pl. LXIV.

Bourguignat, J. R., 1883. *Histoire de la Malacologie d'Abyssinie*, Paris.

Pilsbry, H. A., 1908. *Manual of Conchology*, 19.

Watson, H., 1928 The Affinities of Cecilioides and *Ferussacia* illustrating adaptive evolution. *J. Conch.*, 18.

Germain, L., 1930. Mollusques terrestres et fluviatiles. *Faune de France*, nr. 21, Paris.

Odhner, N. H., 1931. Beitrage sur Malakozoologie der Kanarischen Inseln.. *Ark. Zool.*, 23a, nr. 14.

Thiele, J., 1931. *Handbuch der Systematischen weichtierkunde*, 1. Jena.

Soos, L., 1933. A systematic and zoogeographical contribution to the Mollusc-Fauna of the Maltese Islands and Lampedusa. *Arch. Naturgesch.* 2, pp. 305-353.

Wachtler, W., 1935. Beitrage zur anatomie der Stylommatophoren Lungen-Schnecken. Ueber die Gattung *Ferussacia* Risso. *Zool. Jb. Abt.*, 1, 67.

Pilsbry, H. A., 1946. Land Molluscs of North America (North of Mexico), 2, part 1. Philadelphia.

Quick, H. E., 1952. Emigrant British Snails *Proc. Malac. Soc.*, 29, pp. 181-189.

Quick, H. E., 1953. Helicellids introduced into Australia. *Proc. Malac. Soc.*, 30, pp. 74-79.

Cotton, B. C., 1954. A Catalogue of Introduced Snails and Slugs in Australia. *Rec. S. Aust. Mus.*, 11, pp. 177-187, pl. 1.

Fig. 1.
Ferussacia sp. from South Australia. Jaw. (Coll. Venmans, Nr. 7372, 2.)

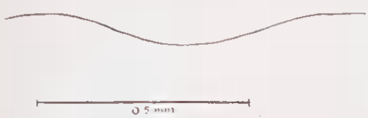

Fig. 2.
Ferussacia sp. from South Australia. Course of the transverse rows of the radula. (Coll. Venmans, Nr. 7372.)

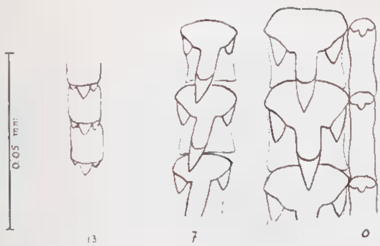

Fig. 3.
Ferussacia sp. from South Australia. Radula, central and first lateral, 7th and 13th teeth. (Coll. Venmans, Nr. 7372.)

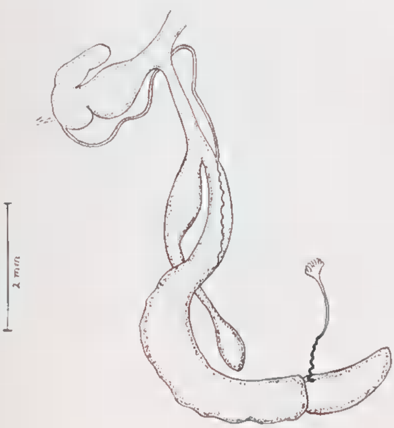

Fig. 4.
Ferussacia sp. from South Australia. Male and female genitalia of one of the specimens. (Coll. Venmans, Nr. 7372, 1.)

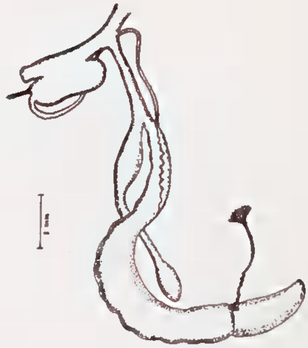

Fig. 5.
Ferussacia sp. from South Australia. Male and female genitalia of one of the specimens. (Coll. Venmans, Nr. 7372, 2.)

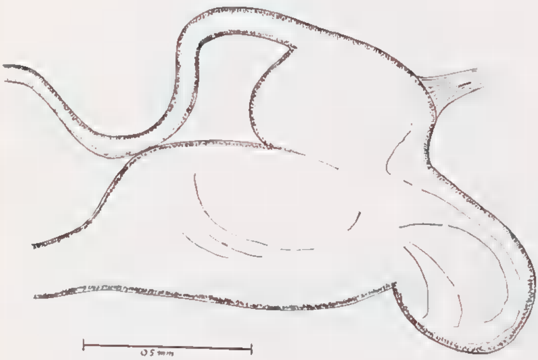

Fig. 6.
Ferussacia sp. from South Australia. Penis of one of the specimens. (Coll. Venmans, Nr. 7372, 3.)

Fig. 7.
Ferussacia sp. from South Australia. Penis of the same specimen as Fig. 4, strongly enlarged. The cavity of the penial appendix is seen through the transparent wall. (Coll. Venmans, Nr. 7372, 1.)

MAGNIFICENT SPECIMENS FROM NEW SOUTH WALES

SEMICASSIS ANGASI Iredale

By THELMA HARTLEY*

Cassidea angasi Brazier, 1911. Shirley, *Proc. Roy. Soc. Q'land*, 23, p. 98.

Xenogalea angasi Iredale, 1927. *Rec. Austr. Mus.*, 15, p. 350, pl. 32, fig. 15.

Iredale, in 1927, figured and described the species *Cassidea angasi*, Brazier's specific name being a *nomen nudum*.

Two magnificent specimens of this rare species taken at Evans Head, New South Wales, in 12 fathoms during September, 1956, have come into my possession. The larger measures, height 49 mm., width 31 mm., and they are figured here.

Close examination reveals that *angasi* has affinity with *Semicassis* rather than *Xenogalea* as introduced by Iredale.

The denticulate outer lip, apertural features and spaced spiral lirae show relationship to *Cassis japonica* Reeve, the type species of *Semicassis* Morch, 1852, rather than with *Cassis pyrum* Lamarck, the type species of *Xenogalea* Iredale, 1927.

I have to thank Mr. Bernard C. Cotton, Curator of Molluscs, South Australian Museum, for helping me with this short paper and supplying the illustrations.

Semicassis angasi Iredale.

* Melbourne, Australia.

ON SOME VICTORIAN CEPHALOPODS

By ROBERT BURN*

(Read 25th February, 1957)

The Victorian list of cephalopod mollusca is not very extensive, very little work having been done on the matter. During the last few years I have collected a number of shallow water forms, among which were 3 species not previously recorded from Victoria. I therefore take this opportunity to record and briefly describe the following 2 species of squid, and one species of octopus.

IDIOSEPIUS NOTOIDES Berry

Idiosepius notoides Berry, 1921, *Rec. S. Aust. Mus.*, 1, No. 4, p. 361. Very small, up to 35 mm. in length, cylindrical body, bluntly rounded behind. Fins small, semi-circular, about one-third as long as body; situated very close to the posterior end. Head separated from body mantle, nearly as wide as body. Tentacles short, about one-third body length. Arms very small and stout. Colour light brown to light grey, in each case with a number of black spots.

Localities: Altona, Portarlington, Swan Bay. (All localities are in Port Phillip Bay.)

Station: Among seaweeds in shallow water.

This is the first record of this species other than from the type locality (Goolwa, South Australia).

EUPRYMNA STENODACTYLA (Grant)

Sepiola stenodactyla Grant, 1833, *Trans. Zool. Soc.*, 1, p. 84, pl. 2. Small, up to 60 mm. long; body broad, rather flat, broadly rounded behind. Fins large, oval in shape, nearly half as long as body, situated midway along body. Head continuous from body mantle, nearly as wide as body. Tentacles nearly as long as body. Arms shorter than tentacles; one is always curled up on the head and is in appearance rather like a ram's horn. Colour grey, profusely spotted with black.

Locality: Portarlington.

Station: Rather common in shallow water.

HAPALACHLAENA MACULOSA (Hoyle)

Octopus maculosa Hoyle, 1883, *Proc. Royal Soc. Edinb.*, 1, No. 7. Small, up to 100 mm. in length; body between one-third and one-quarter of the total length. Arms stout, with 2 rows of suckers. Body terminated in a small, nipple-like protuberance; this feature is more noticeable in preserved specimens. Colour very bright; ground colour bright orange or yellow, arms with blue and brown rings and markings; head and body maculated with similar coloured patches.

Localities: Victorian coastline generally.

Station: Very common under stones, low tide.

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* Geelong, Victoria, Australia.

TASMANIAN INTERTIDAL MOLLUSCA

By RON. C. KERSHAW*

(Abstract)

Study of the Tasmanian Mollusca reveals several aspects of species constitution, of affinity, and ecology, which seems to support the conclusions of other workers dealing with general ecology and with relationships. Thus the mollusca are part of an ecological unit, the basis of which is ecological rather than faunal with affinities for areas of similar latitude probably discernable. The mollusca are also, in general, part of a Southern Australian faunal entity extending to New South Wales and southern Western Australia, yet with individuality, even a note of Neozelanic affinity.

Thus the fauna is identified in this work as a Tasmanian fauna, despite the obvious relationships with the Peronian on the one hand and the Flindersian on the other. In the past, workers have found evidence of these influences which led to the association of East Coast, Tasmania, with the Peronian, and North Coast, Tasmania, with the Flindersian. These ideas are not here denied, rather they are modified. The North Coast has distinct resemblances to the mainland, particularly to Victoria, but it has also strong Tasmanian influences which should not be denied. Collections made on the West Coast suggest that this coast is also Tasmanian in faunal constitution. Thus it is concluded that the features of the faunal constitution on these shores are due more particularly to ecological factors than otherwise. Accordingly, the suggestion made by recent workers that the term "Maugean Region" be extended to include all of Tasmania, as well as Victoria in part, is favoured herein.

Brief reference is made to the migrations of the fauna in relation to Bass Strait. The molluscan fauna of various parts of the shore is described. The constitution of the fauna of the various coasts is described, with some general reference to animals other than the mollusca, also found on these shores, which have ecological associations.

Bass Strait is regarded as a faunal "cross-roads" where there are many influences. This should not be overlooked.

(This work, with references, is to be published in full at a later date.—Editor.)

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OBITUARY

Malacologists here and abroad will be grieved to hear of the sudden death of well-known member, Mrs. Leone (Lee) Woolacott, wife of Ray, who died on Sunday, 4th August. Lee was one of the foremost amateur malacologists in Australia, with a remarkable knowledge of the eastern Australia marine forms in particular, gained by being an excellent field worker and collector, who loved to pack her haversack and tramp with husband Ray, a keen fisherman, to many out-of-the-way beaches and rocky reefs. Later she changed more to car trips, and had all arrangements made for an early visit to Bustard Heads, Queensland. She always planned trips well ahead down to the finest detail, and had a much wider expedition to Darwin and down the north-west coast planned which she and her husband intended to do, probably next year. Lee always kept field notes assiduously to accompany any collecting she did, and her collection at her home in Mosman was efficiently kept and recorded, example of her clear mind and methodical approach. She had reached the stage where she could do serious research on it, and several papers have appeared in recent years in publications of the Royal Zoological Society of New South Wales, and a very interesting account of one of her many trips to Barrier Reef, in *Walkabout*, a few years ago.

Lee was for many years President of the Marine Section of the R.Z.S.N.S.W., during which time she inspired members with her enthusiasm and love of shells, and undoubtedly her term did much towards building the section to its present standard. A quite new and most noteworthy achievement was the innovation of a Juniors' and Beginners' Class, which she and her daughter, Mrs. P. Harford, formed jointly to teach the elements of Malacology, using specimens from her own collection as training aids. This was held one hour before the usual monthly shell night. Lee was an Honorary Correspondent of the Australian Museum and attended there regularly about once a week to assist in the shell department, where she was working on a revision of the bivalve collection with the writer until the latter was forced to retire owing to a severe illness; she then carried on her excellent assistance with Dr. McMichael. Everyone will greatly miss her charming, warm and helpful nature and her clear brain, which combined so vividly to give her the great love of life and living for which she was noted.

—Joyce Allan, F.R.Z.S.

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NOV -2 1958
NATIONAL MUSEUM OF VICTORIA

This is the second Journal to be published by the Society; a Society so young, some might think, and quite reasonably, such a publication beyond its expectations until it 'grew up,' as it were. But with the confidence, the tremendous help of its executive Committee, its rapidly increasing membership and its most enthusiastic members, the first Journal of the Society appeared last year. This issue found its way into no less than 54 countries. Excellent reviews were received from other journals, and much praise from world malacologists. Opinions were generously given that the format, the paper, type, illustrations, and most importantly, the high standard of its articles, were first class. Thus the Journal of The Malacological Society of Australia, set a standard with its initial appearance, which its members intend to uphold in the future, as shown by our Journal No. 2.

Although any malacological journal may equally be chosen for a review by *Nature*, the following covered the Society's first number of its Journal, and says:

"The study of malacology in Australia may be considered to have commenced when *Endeavour*, commanded by Capt. Cook, anchored in Botany Bay, New South Wales, and Dr. Solander collected on its shores in 1770. Since that time a number of malacologists both from outside in the early days and, more recently, from within the continent, have studied its molluscs. While much still remains to be discovered, sufficient is known to indicate that it has one of the richest molluscan faunas in the world. Most of the States have enthusiastic clubs or groups, but it was not until the end of 1956 that the Malacological Society of Australia had its first meeting in Melbourne. In September of the following year the membership was more than 100, and No. 1 of the Journal of the Society appeared. . . . This consists of 52 pages almost identical in size with those of the *Proceedings of the Malacolocial Society*, six of them utilized as plates. It contains eleven articles, of which the longest two deal with epistho-branchs, and the author of the second, Robert Burn, has set an example which it is hoped will be followed by subsequent writers, of presenting type specimens to a national museum. One of the patrons of the Society is Prof. R. Tucker Abbott of the Academy of Natural Sciences, Philadelphia, a very fittting selection in view of the old association between the Academy and Australian malacologists. The paper, printing and general format of the journal are very good, and it is a praiseworthy start. We should like to wish the Society and its journal every success."

Nature, Vol. 181, No. 4623, pp. 1574-1575.

EDITOR.

NOTES ON THE ANATOMY OF THE AUSTRALIAN VOLUTES, *BEDNALLI* and *GROSSI*

By R. TUCKER ABBOTT, Ph.D.,*
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Academy of Natural Sciences of Philadelphia.

(Plate 1, Text figures 1-2.)

I have recently had an opportunity, through the kindness of Colonel Alvin R. Cahn of Tokyo, Japan, and Miss Elizabeth M. Wistar of Chestnut Hill, Pennsylvania, of examining the soft parts of two rare volutes from Australia. This is not an attempt to define or revise the very confusing genera and subgenera of northern Australian volutes. We provisionally place *Cymbiola bednalli* and *C. grossi* in the subgenus *Volutoconus* Crosse, 1871. We use *Cymbiola* Swainson, 1831 (tautotype: *cymbiola* Sowerby, 1825, ex Chemnitz, vol. 10, figs. 1385-1386 = *cymbiola* Gmelin, 1791) in the same broad sense as does Wenz, 1943, pt. 6, p. 1334, who includes *Aulica* Gray, 1847, *Aulicina* Rovereto, 1899, *Callipara* Gray, 1855, and *Volutoconus* Crosse, 1871, as subgenera. We do not follow the very confused revision by Pilsbry and Olsson, 1954.

CYMBIOLA (*VOLUTOCONUS*) *BEDNALLI* Brazier

(Plate 1, fig. 3; text fig. 1)

1879 *Voluta bednalli* Brazier, *Proc. Linn. Soc.*, N.S.W., Vol 3, p. 81, pl. 8, fig. 3 (Port Darwin, Australia); 1894, Sowerby, *Proc. Malac. Soc., London*, Vol. 1, p. 49; 1880, Angas, *Proc. Zool. Soc., London*, for 1880, p. 418, pl. 40, fig. 1 (in colour); Allan, *Australian Shells*, Melbourne, plate opposite p. 224, fig. 1 (in colour).

Our five live-collected *C. bednalli* (ANSP No. 210685) were obtained by Dr. T. Ino off Darwin, North-West Australia, 6th August, 1957, in 23 to 25 fathoms. The bottom is a mud-sand mixture, and *bednalli* lives buried in the bottom with only the tip of the spire projecting above the surface. Live specimens are uncommon.

As indicated by our synonymy, *bednalli* has been adequately figured and described. When fresh, the colour markings on the shell are dark chestnut-brown, but in dead specimens this fades to a light chestnut. In one of our specimens, the body whorl bears 10 long, low, indistinct, axial plications at the periphery. The large, rounded nucleus in all five specimens consists of 3½ whorls, the summit bearing a very small, dark brown spur. This is followed by one smooth, glossy, brown whorl, following which the next 2½ whorls bear numerous low, tiny, axial riblets. There is a minutely raised spiral thread just below the well-impressed suture. The nuclear whorls are yellowish white in colour, with a narrow, irregular brown band just above the suture.

Animal.—The soft parts are typically volutid, rather closely resembling those of *Cymbiola* (*Aulicina*) *vespertillo* Linne in general structure, but without any distinctive colour pattern. The soft parts preserved in alcohol

* Philadelphia, Pennsylvania.

were pinkish in colour. The head is proportionately much smaller than that in *Voluta musica* Linne. Tentacles moderately long and thin. Siphonal appendages short, the left one being only slightly larger than the right. The interior of the rhynchostome is heavily beset with small cartilagenous papillae. Operculum absent.

The odontophore from a shell 103 mm. in length is about 5 mm. in length, narrow, strong, and with 43 rows of strong, uniserial teeth, whose bases are closely set together, so that the cusps overlap two teeth in front. The tooth has a moderate, thick base, a very large, narrow, arching central cusp. On each side is a lateral cusp, which is one-third as large, thinner and narrower. The central cusp is triangular in cross-section.

Remarks: Until the animal of the type species of *Volutoconus* is known (*V. coniformis* Cox 1871, *J. Conchyliol.*, 19, p. 74, pl. 4, fig. 1, Nichol Bay, Western Australia), there will be some doubt as to the wisdom of placing *bednalli* or *grossi* in that subgenus, although on conchological grounds it seems reasonable. The radulae and nuclear shell characters of *bednalli* and *grossi* are quite similar to each other.

CYMBIOLA (*VOLUTOCONUS*) *GROSSI* Iredale.
(Plate 1, Figs. 1, 2, 5; Text fig. 2.)

1927 *Amoria grossi* Iredale, *Aust. Zool.*, Vol. 4, p. 336, pl. 46, fig. 2 (Caloundra).

Description: Adult shell 98 to 116 mm. (3¾ to 4½ inches) in length, solid, elongate, glossy, and salmon-red in colour. Whorls 6 to 7, slightly shouldered, unevenly descending to give the spire a "lop-sided" appearance. Nuclear whorl about 1½, very small, rapidly descending, with slightly concave sides, alabaster white, and raised into a sharp, spine-like projection. Following two post-nuclear whorls bulbous, evenly rounded, regularly descending, weakly malleated, especially the uppermost one, with a dozen microscopic spiral threads, and coloured a bright organge-tan. There is a fine, white spiral line just below the minutely impressed suture. The last 2½ whorls increase their rate of descent, are slightly concave below the suture, and gently swollen at the periphery. Spiral sculpture absent; axial sculpture of numerous, uneven, fine lines of growth, and generally with one or two scars from formerly damaged lips. Ground colour of body whorls yellowish or bluish white, over which is a heavy diffusion of spreading reticulations and mottlings of light carmine red. There are three or four indistinct narrow bands of red showing on the outside of the last whorl. Interior of aperture whitish rose. Outer lip sharp, slightly thickened and slightly compressed at the middle. Columellar plaits well developed, strongly slanting, squarish in cross-section, glossy white with a taint of pink, and the uppermost being the largest. Above the latter there may be a small, swollen, white, button-like callus. Parietal wall sometimes weakly glazed with "melted brown sugar" material. Siphonal fasciole deep, U-shaped, its scar leading back to the second plait from the top. Operculum wanting.

Measurements (mm.)—

Length of Shell	Length of Spire	Width	
115.5	38.0	38.5	ANSP No. 225313
110.3	32.4	36.8	A. J. Ostheimer, 3rd.
111.5	30.0	34.6	John duPont Coll'n
98.2	27.5	33.7	ANSP No. 225313
(118	not given	48	Holotype, fide Iredale, 1927)

Type locality.—Caloundra, north end of Moreton Bay, 60 miles north of Brisbane, Queensland, Australia. Dead shell collected about 1903 by Mr. George Gross.

Additional records.—Miss Elizabeth M. Wistar of Chestnut Hill, Pennslyvania, presented two of the above specimens to the Academy of Natural Sciences of Philadelphia. They and several others were obtained by an Australian correspondent from shrimp trawlers operating in about 33 fathoms, a few miles south-east of Fraser Island, Wide Bay, Queensland. This is about 70 miles north of the type locality.

Animal.—Unfortunately, only one shell (98.2 mm. in length) contained a rotted, dried animal, from which only the odontophore was recovered. The latter consists of a strong, narrow, small ribbon 4.5 mm. in length, with about 35 rows of strong uniserial, tri-cuspid teeth. Their bases are placed close to each other, so that the long cusps overlap the next two teeth. The base is sturdy, thick, and gives rise at the centre to a strong, narrow, arching, central cusp. On each side there is a lateral cusp of about half the size of the middle one.

Remarks.—This rare species was originally described by Iredale as an *Amoria* Gray 1855. However, the Y-shaped, uniserial teeth of *Amoria* bear only a single central cusp, and the nucleus of the shell does not bear a small, spine-like projection. *C. grossi* is now placed in the subgenus *Volutoconus* with some reservation. This is done because of the resemblance of the radula, nucleus and columellar plicae to those of *bednalli*.

A fourth species, *hargreavesi* Angas, in all likelihood belongs to *Volutoconus*, although I have not seen specimens. It was described without locality data (*Proc. Zool. Soc.*, London, for (1872), p. 613, pl. 42, fig. 13), although it possibly comes from Queensland or New Caledonia. *C.* (*V.*) *hargreavesi* resembles *grossi* in colour and general shape, but is considerably broader and has three columellar folds, the upper two being large and almost at right angles to the axis, much as in *bednalli*. From Angas' figure, the apex appears to be obtuse like that in *bednalli*.

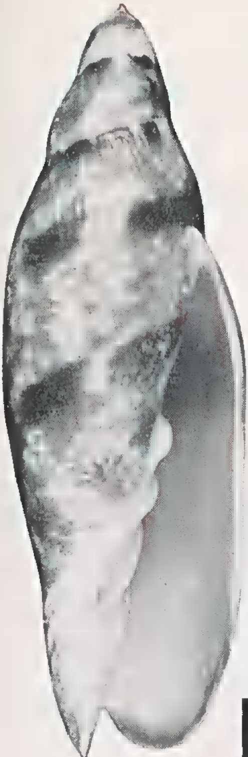
REFERENCES.

Pace, S., 1902. On the Anatomy and Relationships of *Voluta musica*, Linn.; with Notes upon certain other supposed members of the Volutidae. *Proc. Malac. Soc.*, London, Vol. 5, No. 1, pp. 21-31, figs, 1-11.

Cooke, A. H. 1922. The Radula of the Volutidae. *Proc. Malac. Soc.*, London, Vol. 15, pt. 1, pp. 6-12, figs. 1-8.

Pilsbry, H. A., and A. A. Olsson 1954. Systems of the Volutidae. *Bull, of Amer. Paleontol.*, Vol. 35, No. 152, pp. 1-27, 4 pls.

Wenz, W. 1943. *Handbuch der Palazoologie*, Berlin, Vol. 6, pt. 6, pp. 1201-1505.



1

2

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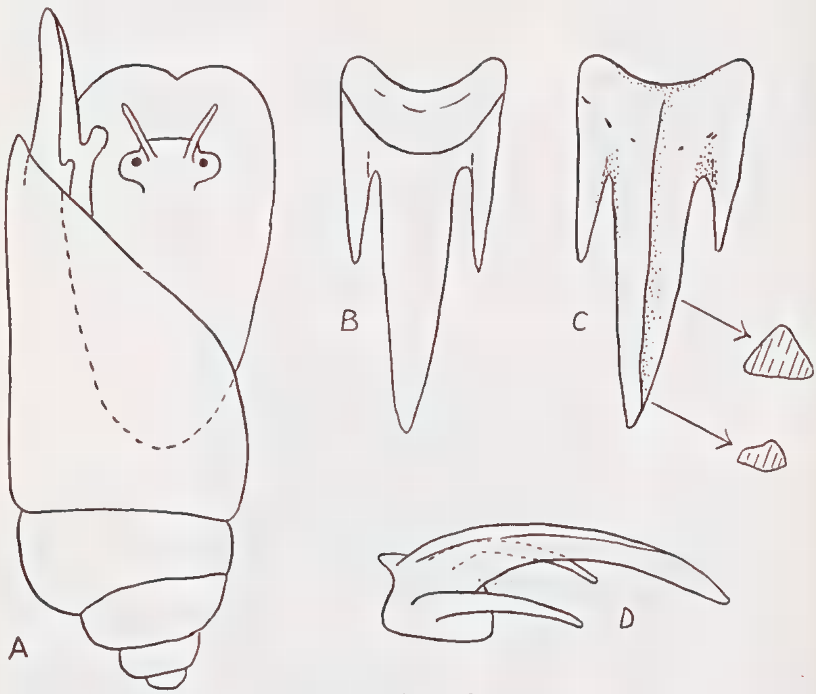
6

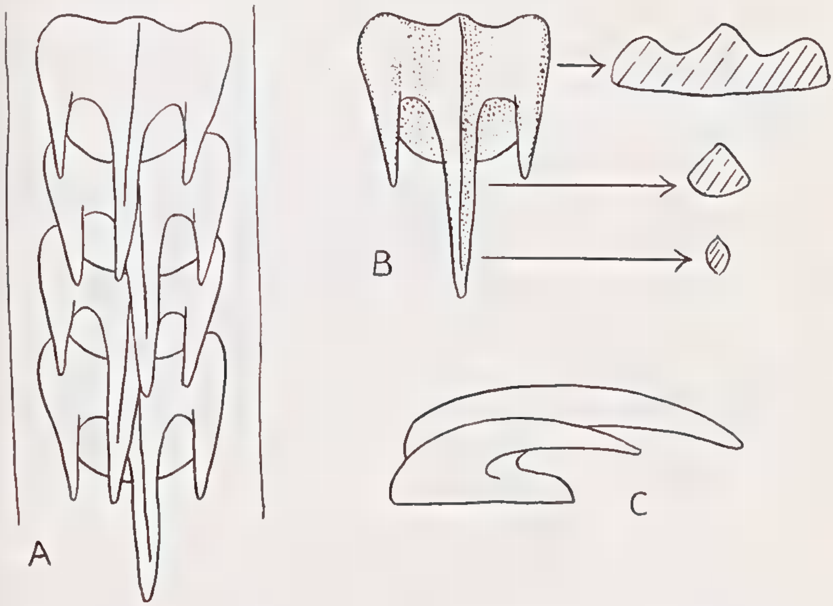
Plate 1.

Plate 1. Figs. 1 and 2, *Cymbiola* (*Volutoconus*) *grossi* Iredale (A.N.S.P. No. 225313); 3, *Cymbiola* (*Volutoconus*) *bednalli* Brazier (A,N.S.P. No. 210685); 4 and 6, *Cymbiola* (*Volutoconus*) *coniformis* Cox (from the *J. Conchyliol*, Vol. 19, pl. 4); 5, apical view of C. (V.) *grossi* Iredale (fig. 5 magnified X 10, others slightly reduced).



Text Figure 1.

Text fig. 1. *Cymbiola* (*Volutoconus*) *bednalli* Brazier. A, dorsal view of soft parts (preserved animal), showing siphon at the left with its two siphonal appendages, the head, foot and visceral mass; B, attachment side of rachidian tooth; C, dorsal view of rachidian tooth showing two cross-sections; D, three-quarter side view of rachidian tooth. (fig. A reduced ½, radula X 100).



Text Fig. 2.

Text fig. 2. *Cymbiola* (*Volutoconus*) *grossi* Iredale. A, dorsal view of odontophore showing alternating arrangement of teeth; B, dorsal view of rachidian showing three cross-sections; C, side view of rachidian tooth. (X 100).

WESTERN AUSTRALIAN COWRIES

By BERNARD C. COTTON, F.R.Z.S.*

(Plates 2-5.)

The last of Charles Hedley's State lists of Mollusca was that dealing with the fauna of Western Australia published in 1916. He realized that Conchologically, this area was comparatively little worked, and that it offered an interesting field for future investigators: so that his list, although so carefully compiled, can be regarded only as a good pioneer effort.

The inter-tropical North-Western fauna differs considerably from the extra-tropical South-Western fauna, though there is an overlap of, say, 20% of the species. This percentage cannot be definitely decided until a more comprehensive and accurate faunal list is available. The fauna of the Dampierian region, extending in Western Australia from Shark Bay to Wyndham, has probably received even less attention from students than that of the Flindersian region, extending from Shark Bay South and East to South Australia, though both areas need much more investigation.

Fortunately, explorations made by Dr. J. C. Verco during 1910-1911 have added to our knowledge of this area, and specimens he collected on the beaches and by dredging are in the South Australian Museum.

As an example of the increased knowledge we now have of Western Australian molluscs, we may take the Cowries. Hedley listed forty species of true Cowries and relatives belonging to the Superfamily Cypraeacea. As a consequence of intensive study, the nomenclature of the Cowries has become enlarged and stabilized, and now we are able to give a more accurate and comprehensive list. We find that Western Australia has about seventy different kinds of Cowries, and still a few more may remain to be discovered. It is not anticipated, however, that many new species will be found. In this paper, space and time permits only the illustration and some remarks on true Cowries, while the Eatoidae, Triviidae (Coffee Bean Shells), Amphiperatidae (Egg Cowries), all of which are represented in Western Australia, are simply listed.

FAMILY CYPRAEIDAE.

SUBFAMILY PUSTULARIIAE.

One species, *Pustularia globula*, with a callous on the spire and without granules, blotching or dorsal sulcus, is the Western Australian representative of this subfamily.

SUBFAMILY STAPHYLAEINAE.

Peculiar representatives of this sub-family is "Wrinkled Cowry" *Nuclearia nucleus* from N.W.A., a small flesh-coloured shell with a wrinkled and noduled surface, and *Staphylaea staphylaea*, with its numerous small granular and spots.

SUBFAMILY UMBILINAE.

Umbilicate shells, known as "Wonder Cowries," live on our Southern Coast. The original specimen found was considered to be a monstrosity of the "Tiger" or "Panther Cowry," but an example later received by the British Museum, from Bass Strait, proved the species to be an authentic one. In

* Adelaide Museum, Adelaide, South Aust.

S.W.A. a rare species, the "Apricot Cowry," *Umbilia hesitata armeniaca,* was dredged by the Federal trawler "Endeavour" in the Great Australian Bight in 100 fathoms. There is no specimen of the species in the South Australian Museum, and all shells labelled "*C. armeniaca*" examined by me in collections have proved to be the Tasmanian *U. hesitata.* It may be found by dredging in Western Australian waters. Of some 2,000 specimens of *U. hesitata* dredged in Bass Strait and examined by C. Kurtze, and many of them by myself, only a few verged to the *U. armeniaca* form.

The ecotype *U. hesitata howelli* Iredale 1931, (*U. hesitata alba* Cox 1880) has not yet been seen from the Flindersian region. Incidentally, there is a miniature white variant of this.

There are nine Tertiary species of this genus found in the Miocene and Pliocene.

SUBFAMILY ZOILINAE.

Another group of Cold-Water Cowries includes the well-known "Black Cowry," common in South Australia, living in a depression on a particular yellow sponge *Ecionemia robusta.* In S.W.A. is found the closely allied *Zoila thersites episema,* and in deeper water occurs *Z. contraria,* first dredged in 100 fathoms, ninety miles west of Eucla. A small relative is the "Dwarf Black Cowry," *Z. decipiens,* common in N.W.A. The most extraordinary one of the lot is *Z. rosselli* from Fremantle, a miniature "Black Cowry" with a keeled edge. On 10th March, while visiting the Nautical Museum, Port Adelaide, I was surprised to find two specimens of *Z. rosselli* on show, probably sent to that Institution by Mr. H. Rossell of Perth. They are now in the Hartley Collection, Melbourne. This accounts for six specimens. It is said, however, that there is a seventh in the Australian Museum, from Cottesloe, W.A. Rather distinct from this group are the more elongated "Cold-Water Cowries," *Z. friendi* and the extremely rare *Z. vercoi,* the original three specimens of the latter being in the South Australian Museum, but Mr. H. Rossell has now kindly added a fourth. There are four Tertiary fossil species of *Zoila.*

SUBFAMILY CYPRAEOVULINAE.

This sub-family includes a series of small Southern Australian shells, such as the "Peppered Cowry" *Notocypraea piperita,* "Verco's Cowry" *N. verconis,* somewhat like a common South African species, the "Flesh-coloured Cowry" *N. subcarnea* and the intricately marked "Mottled Cowry" *N. declivis occidentalis* from S.W.A. and N.W.A. A sinistral specimen of *N. declivis,* from Tasmania, is in the S.A. Museum Collection. It was noticed by Lt.-Col. R. J. Griffiths. Two fossil species somewhat like *N. piperita* are found in the Pliocene of South Australia. A narrower shell is the "Eucla Cowry" *Guttacypraea euclia* taken in 100 fathoms west of Eucla. It is greyish-white with fine teeth. A shallow water relative is *Guttacypraea pulcaria,* more common in S.W.A. than S.A.

SUBFAMILY AUSTROCYPRAEINAE.

A series of nine fossil species of this ancient genus ranges from the Lower to Middle Miocene, while the remarkable *A. reevei* of S.W.A. and S.A. is the only living representative. The animal is beautifully coloured, having a dark amber mantle beset with numerous three to five-pointed

filaments of a peculiar frost-like colour, and on the sides of the mantle are numerous narrow, rectangular black marks appearing to the naked eye as short vertical lines; the foot is amber, its posterior end pink, as are also the siphon and tentacles. All species have shells with a sculpture of hammer-like marks on the dorsum.

SUBFAMILY TALPARIINAE.

Three Cowries of striking colour pattern are found in this subfamily—all occurring in N.W.A. There is the small "Orange-tipped Cowry," *Basilitrona isabella,* the large "Eye Cowry," *Arestorides argus,* pale brown, three banded and covered with numerous brown rings, and the Mole Cowry, *Talparia talpa.*

SUBFAMILY ERRONEINAE.

Five genera of smaller Cowries are represented here. *Erronea* and *Palangerosa,* in which the shell margins are not spotted; *Ovatipsa* and *Blasicrura,* with spotted margins. *Ovatipsa* has coarse teeth and *Blasicrura* has fine teeth.

SUBFAMILY ADUSTINAE.

Five genera are found in Western Australia. *Solvadusta* has a small blotch and speckles and rounded base, *Gratiadusta* has a less rounded base. *Palmadusta* is colour banded. *Cribraria,* represented by the "Mesh Cowry" *C. fallax,* has white spots in a brown mesh, while an extraordinary species, *C. exmouthensis,* has the mesh pattern somewhat obscured. *Albacypraea* is white.

SUBFAMILY NARIINAE.

There are two genera, *Paulonaria,* with a dotted pattern, and *Evenaria,* banded. Both are found in N.W.A.

SUBFAMILY MAURITIINAE.

The first genus, *Mauritia,* is represented by the "Chocolate" or "Mauritius" Cowry, *Mauritia mauritiana* of N.W.A. and central Indo-Pacific, a thick, heavy shell with dark brown to almost black reticulations on its back. The "Arabic Cowry," *Arabica arabica,* has a beautiful medium-sized, dark brown shell, with intricate arabic markings on the back, and a close relative is the "Reticulate Cowry" *A. westralis.* Other species are the more elongate *A. perconfusa,* the smaller *A. scurra,* and also *A. depressa,* all found in N.W.A.

SUBFAMILY EROSARIINAE.

This is a sub-family of small Cowries, some of the species being very prolific. Four genera may be found in N.W.A., and two, *Erosaria* and *Ravitrona,* in S.W.A. as well. *Erosaria* and *Ravitrona* have a spotted colour pattern, the latter being a dark brown shell, of which the "Serpent's Head Cowry," *R. caputserpentis,* is an example. The "Money Cowry," *Monetaria moneta,* varies from a deep yellow to white, but has no colour pattern. The "Ringed Cowry," *Ornamentaria annulus scutellum,* is encircled by a deep red or orange ring. Some specimens have two and even the part of a third ring. Very small adult dwarfs of both species are found off various Pacific Islands.

SUBFAMILY CYPRAEINAE.

These are the typical Cowries, the type specimens being the pretty and plentiful "Tiger Cowry," *Cypraea tigris*. The "Lynx Cowry," *Lyncina lynx*, the "Egg Yolk Cowry," *Mystaponda vitillus*, the "Map Cowry," *Leporicypraea mappa*, and the "Pink-banded Cowry," *Ponda carneola sowerbyi*, a flesh-coloured pink-banded shell, all from N.W.A., complete the list of Western Australian species.

The following is a complete list of W.A. Cowries and their relatives:—

ERATOIDAE.

Lachryma Sowerby 1832. *Erato lachryma* Sowerby 1832.
  denticulata (Pritchard & Gatliff) 1900. Vict. (type), Tas., S.A., S.W.A.
Cypraerato Schilder 1932. *Erato bimaculata* Tate 1878.
  bimaculata (Tate) 1878. S.A. (type), Tas., S.W.A.

TRIVIIDAE

Trivirostra Jousseaume 1884. *Cypraea scabriuscula* Gray 1827.
  oryzoides Iredale 1935. N.W.A. (type).
  = *Trivia oryza* Odhner 1917. Not *oryza* Lamarck.
  paragrando Iredale 1935. N.W.A. (type).
  = *Trivia grando* Odhner 1917. N.W.A. (type).
Dolichupis Iredale 1930. *Cypraea producta* Gaskoin 1836.
  obscura (Gaskoin) 1849. N.W.A. (type).
  = *Trivia bipunctata* (Odhner) 1917. N.W.A. (type).
Cleotrivia Iredale 1930. *Cypraea pilulu* Kiener 1845.
  bathypilula Iredale 1935. S.W.A. (type).
  = *Trivia globosa* Verco 1918, not Gray.
Ellatrivia Iredale 1931. *Triviella merces* Iredale 1924.
  merces (Iredale) 1924. N.S.W. (type), Vict., Tas., S.A., S.W.A.
  = *Cypraea australis* Lamarck 1822. Not Schoeter 1804.

AMPHIPERATIDAE
SUBFAMILY AMPHIPERATINAE.

Amphiperas Meuschen 1781. *Bulla ovum* Linne 1758.
  ovum (Linne) 1758. Amboina (type), N.A., Q., N.S.W.
Pellasimnia Iredale 1931. *Ovulum angasi* Reeve 1865.
  verconis (Cotton and Godfrey) 1932. S.A. (type D.13476, S.A. Mus.), S.W.A.
  depressa (Sowerby) 1875. N.W.A. (type).

SUBFAMILY VOLVINAE.

Volva Bolten 1798. *Bulla volva* Linne 1758.
  = *Radius* Montfort 1810 = *Birostra* Swainson 1840.
  volva (Linne) 1758. Q., N.W.A., N.A.
  = *Volva textoria* Bolten 1798.
Phenacovolva Iredale 1930. *Phenacovolva nectarea* Iredale 1930.
  haynesi (Sowerby) 1889, N.W.A. (type).
  praenominata Iredale 1935. N.W.A. (type).
  = *Radius gracillimus* Schilder 1927, not Smith 1901.
  exsul Iredale 1935. S.W.A. (type).
  = *Ovula philippinerum* Verco 1912.

CYPRAEIDAE

SUBFAMILY PUSTULARIINAE.

Pustularia Swainson 1840. *Cypraea cicercula* Linne 1758.
  globulus (Linne) 1758. N.W.A.

SUBFAMILY STAPHYLAEINAE.

Staphylaea Jousseaume 1884. *Cypraea staphylaea* Linne 1758.
  staphylaea (Linne) 1758. Mauritius (type), Q., N.S.W., N.A., N.W.A.
Nuclearia Jousseaume 1884. *Cypraea nucleus* Linne 1758.
  nucleus nucleus (Linne) 1758. N.W.A., Q., N.A.

SUBFAMILY UMBILINAE.

Umbilia Jousseaume 1884. *Cypraea umbilicata* Sowerby 1825.
  hesitata armeniaca (Verco) 1917. S.W.A. (type).

SUBFAMILY ZOILINAE.

Zoila Jousseaume 1884. *Cypraea friendi* Gray 1831.
  friendi friendi (Gray) 1831. S.W.A., Swan River (type).
  = *Cypraea scotti* (Broderip) 1832.
  friendi vercoi Schilder 1930. S.W.A., Esperance (type D.14124, S.A. Mus.).
  thersites thersites (Gaskoin) 1848. S.A. (type).
  = *Cypraea marginata* Gaskoin 1848.
  thersites contraria Iredale 1935. S.W.A. (type). Deep water.
  thersites venusta (Sowerby) 1847. N.W.A. (type).
  = *Cypraea thatcheri* Cox 1869.
  = *Cypraea bakeri* Gatliff 1916.
  = *Cypraea brunnea* Cox 1889.
  thersites episema Iredale 1939. S.W.A. (type).
  decipiens (Smith) 1880. N.W.A. (type).
  rosselli (Cotton) 1948. S.W.A., Fremantle (type D.14220, S.A. Mus.).

SUBFAMILY CYPRAEOVULINAE.

Notocypraea Schilder 1927. *Cypraea piperita* Gray 1825.
  piperita (Gray) 1825. S.A. (type), S.W.A., N.S.W., Vict., Tas.
  bicolor (Gaskoin) 1849. Tas. (type), Vict., S.A., S.W.A., N.S.W.
  mayi (Beddome) 1898. Tas. (type), S.A., S.W.A., N.S.W., Vict.
  declivis occidentalis Iredale 1935. S.W.A., Geographe Bay (type); N.W.A.
  subcarnea (Beddome) 1896. Tas. (type), S.A., S.W.A., N.S.W., Vict.
  = *Cypraea albata* Beddome 1897.
  verconis Cotton and Godfrey 1932. S.A. (type D.13474, S.A. Mus.), S.W.A., N.W.A., N.S.W., Vict.
Guttacypraea Iredale 1935. *Cypraea pulicaria* Reeve 1846.
  pulicaria (Reeve) 1846. S.W.A. (type), S.A.
  = *Guttacypraea pulicaria candida* Coen 1949.
  euclia Steadman & Cotton 1946. S.W.A., 100 fms., 40 miles W. of Eucla (type D.11634, S.A. Mus.).

SUBFAMILY AUSTROCYPRAEINAE.

Austrocypraea Cossmann 1903. *Cypraea contusa* McCoy 1877 (fossil).
  = *Prolyncina* Schilder 1927. *Cypraea reevei* Sowerby 1832 (recent).
  reevei (Sowerby) 1832. S.W.A. (type), S.A.

SUBFAMILY TALPARIINAE.

Talparia Troschel 1863. *Cypraea talpa* Linne 1758.
talpa (Linne) 1758. Amboina (type), N.W.A.
Basilitrona Iredale 1930. *Cypraea isabella* Linne 1758.
isabella isabella (Linne) 1758. N.W.A., Q., N.S.W., N.A.
= *Basilitrona isabella rumphi* Schilder and Schilder 1939.
Arestorides Iredale 1930. *Cypraea argus* Linne 1758.
argus argus (Linne) 1758. N.W.A.
= *Cypraea argus contrastriata* (Perry) 1811.

SUBFAMILY ERRONEINAE.

Erronea Troschel 1863. *Cypraea erronea* Linne 1758.
nimisserans nimisserans Iredale 1935. Q. (type), N.S.W., N.A., N.W.A.
nimisserans coxi (Brazier) 1872. N.W.A., Depuch Is. (type).
magerrones proba Iredale 1939. N.W.A. (type), N.A.
Palangerosa Iredale 1930. *Cypraea cylindrica* Born 1780.
cylindrica sista Iredale 1939. N.W.A. (type).
Ovatipsa Iredale 1931. *Cypraea chinensis* Gmelin 1791.
caurica blaesa Iredale 1939. N.W.A. (type), N.A.
chinensis variolaria (Lamarck) 1810. Amboina (type), N.W.A.
Blasicrura Iredale 1930. *Cypraea rhinoceros* Souverbie 1865.
irvineanae (Cox) 1890. S.W.A., Cape Naturalist (type).
Bistolida Cossmann 1930. *Cypraea stolida* Linne 1758.
stolida stolida (Linne) 1758. Ceylon (type), Broome, N.W.A.
quadrimaculata (Gray) 1824. Amboina (type), N.W.A., N.A.

SUBFAMILY ADUSTINAE.

Palmadusta Iredale 1930. *Cypraea clandestina* Linne 1758.
clandestina (Linne) 1767. N.W.A. (type).
lutea bizonata Iredale 1935. N.W.A. (type).
Gratiadusta Iredale 1930. *Cypraea pyriformis* Gray 1825.
pyriformis pyriformis (Gray) 1825. N.W.A., Q., N.A. (type).
pyriformis smithi (Sowerby) 1881. N.W.A. (type).
kaiseri (Kenyon) 1897. N.W.A. (type), N.A., Q.
walkeri comptoni (Gray) 1847. N.A. (type), N.W.A.
Solvadusta Iredale 1935. *Gratiadusta vaticina* Iredale 1930.
subviridis subviridis (Reeve) 1835. N.Q. (type), N.A., N.W.A.
= *Adusta dorsalis* Schilder & Schilder 1938.
Albacypraea Cotton & Steadman 1946. *Cypraea eburnea* Barnes 1828.
eburnea (Barnes) 1828. Fiji (type), Manus, New Guinea, Q., N.A. N.W.A.
Cribraria Jousseaume 1884. *Cypraea cribraria* Linne 1758.
cribraria fallax (Smith) 1881. N.W.A., S.W.A.
cribararia exmouthensis (Melvill) 1888. N.W.A. (type).

SUBFAMILY NARIINAE.

Paulonaria Iredale 1930. *Cypraea beckii* Gaskoin 1836.
= *Opponaria* Iredale 1939. = *Cupinota* Iredale 1939.
macula hilda Iredale 1939. N.W.A., Shark Bay (type).

Evenaria Iredale 1930. *Cypraea asellus* Linne 1758.
asellus (Linne) 1758. Amboina (type), N.W.A., N.A.
punctata carula Iredale 1939. N.A., Q. (type), N.W.A.
hirundo cameroni Iredale 1939. N.A. (type), N.W.A., Q., N.S.W.

SUBFAMILY MAURITIINAE.

Mauritia Troschel 1863. *Cypraea mauritiana* Linne 1758.
mauritiana regina (Gmelin) 1791. N.W.A., Central Indo-Pacific.
Arabica Jousseaume 1884. *Cypraea arabica* Linne 1758.
arabica arabica (Linne) 1758. N.A., N.W.A., Q.
arabica westralis Iredale 1935. N.W.A. (type), N.A., Q.
eglantina perconfusa Iredale 1935. N.W.A. (type), N.A., Q.
scurra scurra (Gmelin) 1791. N.W.A., N.A., Q.
= *Cypraea indica* Gmelin 1791.
= *Cypraea amarata* Morch 1852.
depressa depressa (Gray) 1824. N.W.A., N.A., Q.
= *Cypraea intermedia* Redfield 1847.
= *Cypraea gillei* Jousseaume 1893.

SUBFAMILY EROSARIINAE.

Erosaria Troschel 1863. *Cypraea erosa* Linne 1758.
erosa phagedaina (Melvill) 1888. N.W.A., S.W.A.
inocellata diversa (Kenyon) 1902. N.W.A., Shark Bay (type D.3903, S.A. Mus.).
Ravitrona Iredale 1930. *Cypraea caputserpentis* Linne 1758.
caputserpentis caputserpentis (Linne) 1758. N.W.A., S.W.A., N.S.W., Q., N.A.
caputserpentis kenyonae Schilder & Schilder 1919. N.W.A. (type).
helvola citrinicolor Iredale 1935. N.W.A. (type).
wilhelmina (Kenyon) 1897. N.W.A. (type D.14447, S.A. Mus.).
Monetaria Troschel 1863. *Cypraea moneta* Linne 1758.
= *Aricia* Broderip 1837.
moneta moneta (Linne) 1758. N.W.A.
moneta rhomboides Schilder & Schilder 1933. N.W.A. (type).
Ornamentaria Schilder & Schilder 1936. *Cypraea annulus* Linne 1758.
annulus scutellum Schilder & Schilder 1937. N.W.A.

SUBFAMILY CYPRAEINAE.

Cypraea Linne 1758. *Cypraea tigris* Linne 1758.
tigris tigris Linne 1758. N.W.A. (type), N.A., Q.
Lyncina Troschel 1863. *Cypraea lynx* 1758.
lynx lynx (Linne) 1758. N.W.A., Q.
= *Cypraea vanelli* Linne 1758.
= *Cypraea michaelis* Melvill 1905.
Mystaponda Iredale 1930. *Cypraea vitellus* Linne 1758.
vitellus vitellus (Linne) 1758. N.W.A., N.A., S.W.A., N.S.W.
= *Cypraea distorta* Cox 1889. preocc.
Leporicypraea Iredale 1930. *Cypraea mappa* Linne 1758.
mappa mappa (Linne) 1758 N.W.A., N.A., Q.
= *Mauritia geographica* Schilder & Schilder 1934.

Ponda Jousseaume 1884. *Cypraea ventriculus* Lamarck 1810: *carneola sowerbyi* (Anton) 1839. N.W.A. = *Cypraea loebbeckeana* (Weinkauff) 1881.

PLATE 2.

Umbilia hesitata armeniaca (Verco).
Zoila thersites episema Iredale.
Zoila decipiens (Smith).
Zoila friendi vercoi Schilder.
Zoila friendi (Gray).
Zoila rosselli Cotton.

PLATE 3.

Nuclearia nucleus (Linne).
Guttacypraea pulicaria (Reeve).
Notocypraea occidentalis Iredale.
Notocypraea piperita (Gray).
Notocypraea verconis Cotton & Godfrey.
Austocypraea reevei (Sowerby).

PLATE 4.

Basilitrona isabella (Linne).
Arestorides argus (Linne).
Erronea nimisserans Iredale.
Palangerosa cylindrica sista Iredale.
Solvadusta subviridis (Reeve).
Cribraria cribraria exmouthensis (Melvill).

PLATE 5.

Mauritia mauritiana regina (Gmelin).
Arabica scurra (Gmelin).
Ravitrona caputserpentis kenyonae Schilder & Schilder.
Cypraea tigris Linne.
Mystaponda vitellus (Linne).
Ponda carneola sowerbyi (Anton).

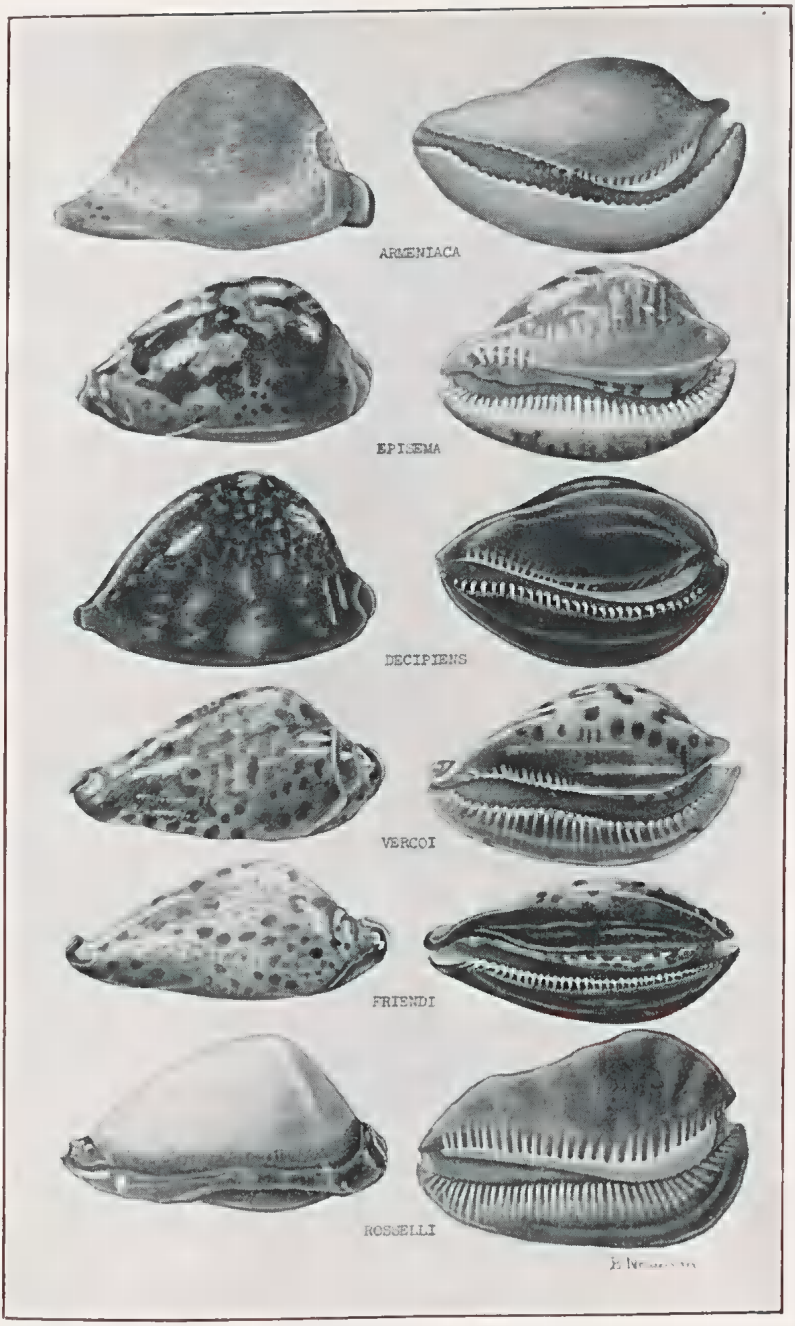


Plate 2.

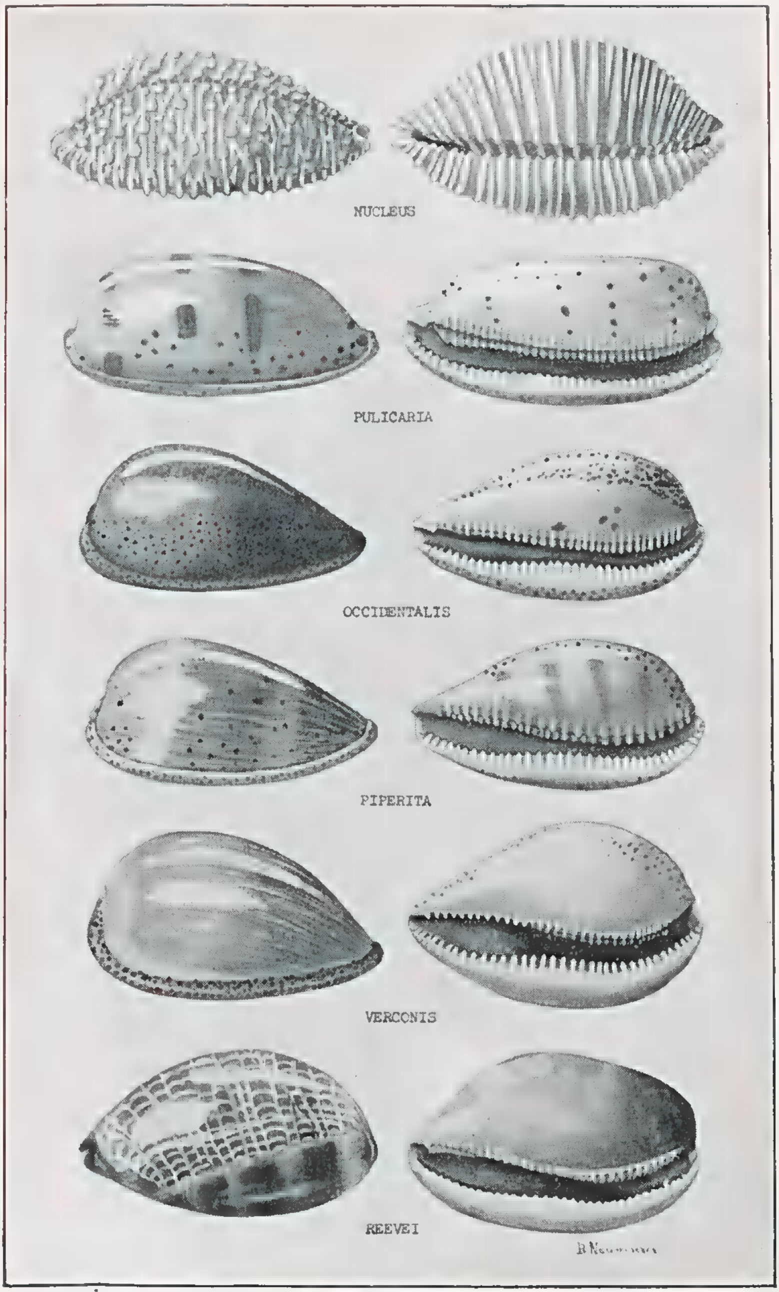

NUCLEUS
PULICARIA
OCCIDENTALIS
PIPERITA
VERCONIS
REEVEI

Plate 3.

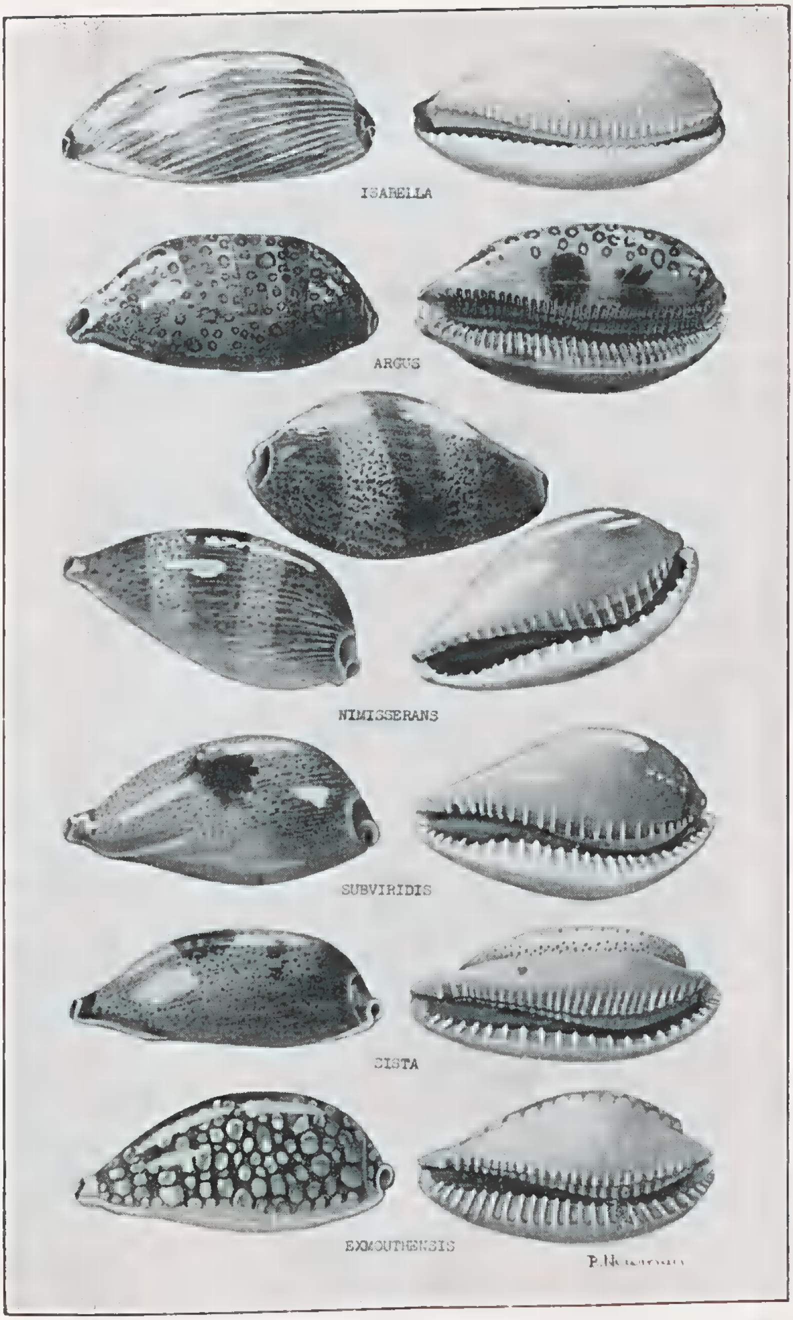

ISABELLA
ARGUS
NIMISSERANS
SUBVIRIDIS
CISTA
EXMOUTHENSIS

Plate 4.

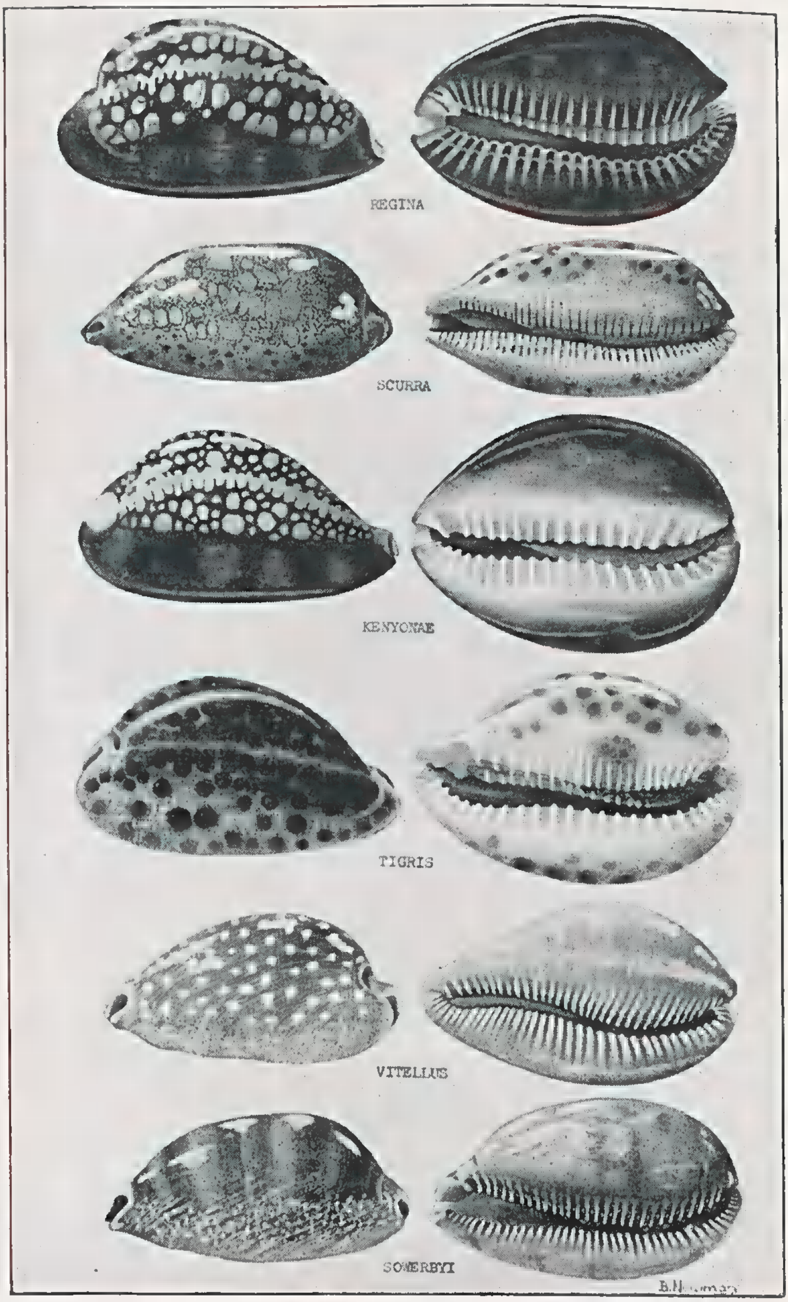


Plate 5.

FURTHER VICTORIAN OPISTHOBRANCHIA

By ROBERT BURN*

(Read 31st March, 1958)
(Plates 6-7; Text figures 1-9)

INTRODUCTION

This is the third paper of a series to be published concerning Victorian Opisthobranchia. The first two appeared in the latter half of 1957 and dealt with 36 species, a number of which were described as new. This paper deals with 15 species, of which 12 are new records for this State; one new genus is proposed for the reception of a quite common species, and 9 species are described for the first time. This brings the list of Victorian Opisthobranchia to 48 species divided among 32 genera.

The localities from which all species have been collected are in the recently proposed Victorian Maugean Region, but within the Peronian influence. This has apparently been the reason why a number of species described from Sydney Harbour, New South Wales, by Angas (1864) are quite common here. But some of these species of Angas' are rare in their type locality and have been seen only once or twice over the intervening years since description. These species, i.e., *Praegliscita chrysoderma* (Angas), *Madrella sanguinea* (Angas), *Melibe australis* (Angas) and *Paliolla cooki* (Angas) are rather common at most localities at which collecting has been undertaken by this author.

Could it be that the Peronian Region is somewhat influenced by this Victorian Maugean Region, and was it at one of these times that Angas collected his species?

Two species recorded here were first described from European waters, one of which is also recorded from Japan. The other is quite remarkable for its most peculiar rhinophoral construction. The species of *Elysia* here described as new is the third of its genus from Australia—surely this genus must occur in a number of species along our northern and western coastlines in tropical waters? As it is, the three species known all occur on our east or south-east coast.

Unless otherwise stated, all specimens of species described or recorded here were collected by the author.

The type specimen of each new species, along with specimens of other newly recorded species, are to be presented to the National Museum of Victoria, Melbourne.

The systematic position of the species dealt with in this paper can be set out as follows:—

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* Geelong, Victoria, Australia.

(* Denotes species not previously recorded from Victoria.)

Class - - -	GASTROPODA
Subclass - -	OPISTHOBRANCHIA
Order - - -	Anaspidea
Family - - -	**APLYSIIDAE**
	**Aplysia hyalina* Sowerby
Order - - -	Sacoglossa
Suborder - -	Elysiacea
Family - - -	**ELYSIIDAE**
	**Elysia furvacauda sp. nov.*
Order - - -	Notaspidea
Suborder - -	Pleurobranchacea
Family - - -	**PLEUROBRANCHIDAE**
	Pleurobranchaea maculatus (Quoy and Gaimard)
Order - - -	Nudibranchia
Suborder - -	Doridacea
Superfamily	Eudoridacea
Group - - -	Phanerobranchia
Family - - -	**POLYCERIDAE**
	**Palio parvula sp. nov.*
	Paliolla cooki (Angas) *gen. nov.*
	**Kaloplocamus ramosus* (Cantraine)
Family - - -	**ACANTHODORIDIDAE**
	**Lamellidoris maugeansis sp. nov.*
Family - - -	**OKENIIDAE** (= Goniodorididae)
	**Goniodoris meraculus sp. nov.*
Group - - -	Cryptobranchia
Family - - -	**DORIDIDAE**
	**Hallaxa indecora* (Bergh)
	**Rostanga hartleyi sp. nov.*
	Alloiodoris nivosus sp. nov.
	Platydoris galbanus sp. nov.
Suborder - -	Arminacea
Superfamily	————
Family - - -	————
	**Janolus hyalina* (Alder and Hancock)
	**Proctonotus? affinis sp. nov.*
Suborder - -	Dendronotacea
Family - - -	**DOTONIDAE**
	**Doto ostentus sp. nov.*

DESCRIPTIONS OF SPECIES

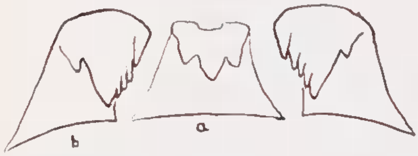
APLYSIA HYALINA Sowerby

(Text fig. 1)

Aplysis hyalina Sowerby 1869, *Conchyl. Icon.*, 17, pl. 4, sp. 13.

Body large, upwards of 200 mm.; parapodia large, separated behind. Mantle aperture closed with a strong papilla on the spot of the closure. Rhinophores and cephalic tentacles large, stout, and crenulate on the distal ends. With a large, strong purple gland. Radula formula 50 x 23.1.23. Median tooth small, cusp rounded, with one large denticle either side;

laterals large, triangular, with one large denticle either side and three smaller ones on the inner edge. Body-colour dark purple-brown, with a few faint interlacing black lines on the outer surfaces of the parapodia and neck. The shell is large, 50 mm. long by 42 mm. broad, nearly flat, extremely thin and membranous; pale greenish-yellow in colour.



Text Fig. 1.
Aplysia hyalina Sowerby.
Single row of radula; a—central tooth, b—typical lateral tooth.

Localities: Rosebud (2 spec., May, 1954); Swan Bay (2 spec., April, 1955).

Station: Common, crawling on sand and weed in a few feet of water, low tide.

Remarks: This is the species referred to by the author (1957) as *A. tigrina* Rang = *A. sowerbyi* Pilsbry. Since then, however, a comparison of New South Wales and Victorian specimens have shown that the above is the correct name.

ELYSIA FURVACAUDA sp. nov.

(Pl. I, fig. I)

Typical *Elysia*. Body limaciform, up to 19 mm. in length; parapodia narrow, extending along either side of body for more than three-quarters of total length. When closed together, the parapodia form two distinct holes along the mid-dorsal line; the anterior hole is nearly the width of the body in diameter, while the other is much smaller; rhinophores large, auriculate slightly involute. Anus emerges a little to the right of the median-line on the anterior edge of the pericardium, which is medianly placed just behind the anterior edges of the parapodia. Body colouring is dark red-brown, outer sides of parapodia speckled with numerous small pale blue spots. The parapodia margins, when together, form a blue mid-dorsal line outlined on either side by a line of interrupted white. Margins of holes plain white; upper anterior portion of each parapodia greyish-blue. Slender neck, pale pinkish-brown; base of the rhinophores and the neck spotted with white dots. Rhinophores and tail tipped with black.

Locality: Torquay (1 spec., Sept., 1957).

Station: Unique, under stone at mid-tide.

Remarks: While under observation this specimen showed certain colour changes over a period of 24 hours. The colours noted above were those when first collected. After 24 hours the body-colour was dull brown, with many more larger blue spots on the sides than previously; the anterior blue patch had become very intense. Unfortunately, after two days the specimen died, and when placed in spirits became pale pink, still with black tips, but with no trace of blue.

E. australis Quoy and Gaimard and *E. marginata* (Pease), from New South Wales, are both predominantly green in body-colour, which at once separates the present species from them.

PLEUROBRANCHAEA MACULATUS (Quoy and Gaimard)

Pleurobranchidium maculatus Quoy and Gaimard, 1832, *Voy. "Astrolabe." Zool* 2, p. 301, pl. 22, fig. 11-12.

= *Pleurobranchaea novaezealandiae* Cheeseman, 1878, *Proc. Zool. Soc., Lond.*, p. 276, pl. 15, fig. 3.

= *Pleurobranchaea dorsalis* Allan, 1933, *Rec. Aust. Mus.*, 18, No. 9, p. 445, pl. 56, fig. 4-5.

The above name was overlooked by the author when compiling the first list of Victorian Opisthobranchia; and in its stead *P. novaezealandiae* Cheeseman was used. From a quick glance at the figures and description of *P. maculatus* any species could be suggested to fit the name; but the type locality is Westernport Bay, Victoria. The description of *P. novaezealandiae* seemed to be closer to our species at the time, and this therefore was the name used.

Since that time, however, a further number of specimens have come to hand, including a large specimen from Flinders, Westernport Bay. These have led to a reconsideration of species, and the results are such that *P. maculatus* (Q. and G.) should be used, and that *P. novaezealandiae* Cheeseman is synonymous.

The other species of *Pleurobranchaea*, *P. dorsalis* Allan, recorded from New South Wales and Tasmania, is, from its description, undoubtedly the same species, although perhaps a warmer sea ecological varient. It has been observed that certain species become paler in colour as they move into colder waters, and, therefore, if this is so, then *P. dorsalis* can also be accepted as a synonym of *P. maculatus*.

Finally, if the above synonomy is accepted, then it would appear that *P. maculatus* is an inhabitant of the temperate and cool-temperate regions of the Pacific. It has been recorded as common in Japan and occurring in China by Baba (1949), and has been collected in New Zealand, New South Wales, Victoria and Tasmania.

Victorian localities for the species include Lorne, Apollo Bay, Queenscliff, Sorrento, and Flinders, Westernport Bay.

PALIO PARVULA *sp. nov.*

(Pl. I, fig. 2-3, text fig. 2)

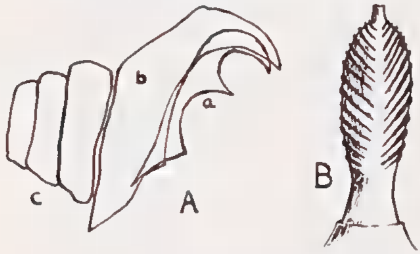
Very small limaciform animal, 9 mm. in length. Velar processes 2; large and digitiform. Pallial ridge consisting of a row of (8-9) broadly-spaced points along either side. Branchial plumes 5 in number; bipinnate, non-retractile. Anterior edge of branchial cavity with 7 low papillae placed evenly in a semi-circle. Rhinophores large, non-retractile, perfoliate. Oral tentacles indistinct, lobiform. Foot very narrow; sole pink, edged with orange; anterior corners rounded. Genital orifice large. Body-colour maroon, maculated with white. Velar processes dorsally orange, ventrally white. Pallial ridge points yellow; papillae anterior to branchiae bright red. Branchiae and rhinophores dark red. Radula formula 11 x 3.2.0.2.3. First lateral small, hamate, calcarate, spur large and half way down the inner side. Second lateral, hamate. Remaining 3 laterals simple, scale-like.

Locality: Torquay (1 spec., Dec., 1956; 2 spec., Oct.-Dec., 1957).

Station: Uncommon, under stones at low tide.

Remarks: This species is placed in the genus *Palio* Gray in preference to *Polycera* Cuvier as the nature of the velar processes and pallial ridge warrant it. *Palio* is generally accepted as a synonym of *Polycera* (or as a subgenus, if this name is used at all). The radula is typical of *Polycera*, and, while this alone can place a species in a genus, the external features in the author's opinion place the species in the genus *Palio*.

This species has as yet no congeners occurring in Australian waters.



Text fig. 2.
Palio parvula sp. nov.
A—half row of radula,, a—first lateral, b—second latertal, c—outer laterals, B—rhinophore.

PALIOLLA gen. nov.

Animal polyceridiform; body limaciform, very soft, pallial ridge not prominent, consisting of a row of small pointed papillae. Branchial plumes few in number, bipinnate and sub-retractile. Branchial cavity cresentic, anterior lip strong. Rhinophores large, perfoliate, retractile. Radula degenerate; all that remains is a group of calcareous rods in the form of a long, slender tube. These are supported on either side by a further series of minute rods.

Type species: *Polycera cooki* Angas.

This genus is proposed for the reception of a single species *P. cooki* (Angas); the most unusual odontophore features being different from any other known genus. The number, form and shape of the rods make it impossible to formulate a normal radula. The supplementary rods on either side of the large ones may be the remains of a normal radula, or again may be the first signs of a radula with the subsequent decrease of the central tubiform portion.

Gymnodoris Stimpson, which has numerous branchiae, is very similar to *Paliolla*, a genus which has but a few. *Gymnodoris* has a divided hermaphrodite gland, which is formed into globules, but whether it is the same in *Paliolla* remains to be seen. It is worth noting that the outer lateral teeth of the radula in *Gymnodoris spp.* are long and slender, but on a broad base, so much so that there is actually a great similarity between them and the central rods in *Paliolla*.

Possibly *Paliolla* is an archaic genus in the phanerobranchiate Nudibranchia, as is *Gymnodoris*.

PALIOLLA COOKI (Angas)

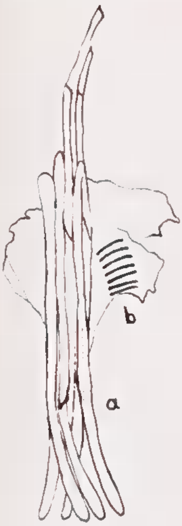
(Pl. I, fig. 4; text fig. 3)

Polycera cooki Angas, 1864, *J. Conchyliol*, 12, p. 58, pl. 5.

Body small, limaciform, very soft; up to 17 mm. in length and 4 mm. in width. Pallial ridge comprising many small, soft papillae. Dorsum separated from sides by pallial ridge, but continuous into tail. Rhinophores large, clavate, perfoliate, with 8 very steep laminae. Branchiae 5 in

number, bipinnate, sub-retractile, arranged in a broad crescent. Branchial cavity with a strong anterior lip. Foot not as wide as body, square and grooved anteriorly. No oral tentacles, mouth a large pore in a depression just above the foot. Body-colour orange or yellow; entirely covered with minute strawberry-red dots; foot whitish. Pallial ridge red or white. Internally below the branchiae there is a large, bright pink mass.

Radula peculiar; tubiform, comprising 9 long, slender rods in three series. The first or anterior series—length about two-thirds of total—comprises 5 equal-length rods, the anterior ends rounded and curved outwards, providing a funnel-like inlet. The second series of two rods is placed medianly; length 1.3 mm.; anterior ends sharply pointed; posterior ends



Text fig. 3.
Paliolla cooki (Angas).
Complete radula.
a—central tubiform portion, b—minute supporting rods.

rounded. The third series, again of two rods, is placed at the posterior end of the tube, length same as second series; anterior ends sharply pointed; posterior ends broken and bent to one side. Total length of rods in largest specimen 2.5 mm. Laterally, at half length of the second series, are two wings, each of which has 7 minute rods parallel to each other, but at an angle of slightly less than 45 degrees to the main tube.

Localities: Breamlea (1 spec., Nov., 1955); Torquay (2 spec., Dec., 1955, 2 spec., Mar., 1957, 2 spec., Dec., 1957); Aireys Inlet (1 spec., April, 1957).

Station: Not uncommon, usually in pairs, under stones near low tide level.

Remarks: As can be seen from the remarkable buccal features, this species is indeed hard to place in any existing genus. Previously it has been placed in *Polycera* by Angas and in *Palio* by Bergh, although personally the author would have preferred to place the species in *Gymnodoris*. But the degenerate radula, while reminiscent of *Gymnodoris*, is sufficiently different as to allow the erection of a new genus.

KALOPLOCAMUS RAMOSUS (Cantraine)

Doris ramosus Cantraine, 1835, *Acad. Roy. Sci., Bruxelles,* Bull. No. 2, p. 383.

Length 22 mm.; body limaciform; head slightly broader than body; margin of head with 8 dendritic processes. Dorso-lateral processes dendritic, in 5 pairs. Branchiae 5 in number, bipinnate and non-retractile. Rhinophores clavate; clavus small and perfoliate; stalks very long and slender. Oral tentacles lobiform. Foot narrow, thickened anteriorly. "Radula formula at most 43 x 37.3.0.3.37. The first three laterals large, hamate; the rest scale-like" (Baba, 1949). Body-colour pale orange speckled with white, with a single row of white dots along either side. Clavus of rhinophores red, stalks clear; velar and dorso-lateral processes colourless. Branchiae either colourless or bright red, the latter with or without white tips.

Locality: Torquay (1 spec., Oct., 1957, 2 spec., Jan., 1958).

Station: Rare, under stones near low tide.

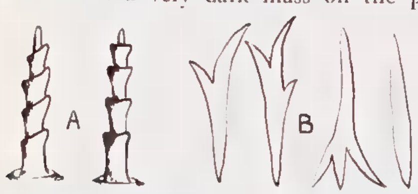
Remarks: This species is recorded from the Mediterranean (type locality) and Japan. The above specimens agreed exactly with the figure given by Baba (1949), *Opisthobranchia of Sagami Bay* (Tokio) pl. 13, fig. 47.

Triopa yatesi Angas, from Port Jackson, undoubtedly belongs to this genus, and may even be the same as the above species. Certain differences between the two species are easily seen, and until *T. yatesi* is again collected and studied its validity must remain in doubt.

LAMELLIDORIS MAUGEANSIS sp. nov.

(Pl. 2, fig. 8-9 text fig. 4)

Length 8 mm., breadth 5 mm. Doridiform body, dorsal surface covered with a multitude of blunt-pointed papillae; height upwards of 2 mm.; retracted they appear as low, stud-like pustules. Integument of mantle densly spiculose; spiculae of many forms, some simple, some divided and some calcarate. Rhinophores claviform, with 4 large oblique laminae, retractile. Margins of rhinophore openings smooth. Branchiae 4 in number, simply pinnate, arranged in a shallow horseshoe crescent in front of the anal papilla. Branchial cavity transversely oval. Head broad, crescent shaped, with the extremities formed into stout digitiform processes. Mouth large. Foot broad anteriorly and tapers sharply to a blunt tail—does not extend beyond mantle margin. Body-colour orange-yellow, foot clear. Ventrally the mantle is transparent, and the silver and gold spiculae are very visible when viewed with a low-power lense. Rhinophores and branchiae faintly yellow, with openings rimmed with gold. The liver forms a very dark mass on the posterior left side. Radula too small



Text fig. 4.
Lamellidoris maugeansis sp. nov.
A—Rhinophore viewed from side and front. B—mantle spiculae, 4 forms.

for examination by the author, but there was seen to be 22 rows of teeth. Labial armature not noticed, although a small amount of oral cuticle was present.

Localities: Torquay (8 spec., Oct.-Nov., 1957, type locality); Breamlea (1 spec., Jan., 1958).

Station: Not uncommon, under stones at low tide. Usually in crevices or holes where a certain amount of mud accumulates.

Remarks: Very hard to find, as the body-colour usually blends with the muddy background; often in colonies of numerous individuals.

This species has no congeners in Australian waters, but a closely allied genus, *Acanthodoris*, occurs in Tasmania.

GONIODORIS MERACULUS *sp. nov.*

(Pl. 2, fig. 10-11)

Body stoutly limaciform, angular; length 17 mm. Dorsal surface smooth, half as broad as foot anteriorly, and a little broader near the branchiae. Pallial margin a very thin, narrow, rim-like flange, minutely crenulate and roughened, continuous all round except behind the branchiae. Rhinophores linear-clavate, perfoliate, with 12 or more very fine laminae; situated extremely close to the anterior pallial ridge. Branchiae large, bipinnate, 7 in number, all joined at the base and arising not from a cavity, but from the dorsal surface surrounding the large anus. Foot broad, flat, minutely flecked with white, square in front, with a wide notch below the head. Tail ridged from behind branchiae to tip. Head large, produced well forward and sideways; orals linear; a low ridge from pallial rim to edge of head; eyes visible as black dots either side of the head ridge. Mouth a vertical slit; jaws occasionally visible as two brown plates inside the mouth. Radula not examined. Genital orifice a large elliptic pore behind the line of the rhinophores. Body-colour pale greenish-yellow, heavily maculated with white. Region around branchiae pink, internally black. Rhinophores with brown stalks and yellow clavi; branchiae clear or pale pink; pallial rim yellowish. Underside of head around mouth dark brown.

Locality: Torquay (1 spec., Dec., 1957).

Station: Most rare, nested in a shallow depression on a species of slimy encrusting sponge under a stone at low tide.

Remarks: When first observed alive, this species appeared to be a yellowish sea-anemone, around which some sponge growth had encroached. The author poked the "anemone" to see if it would retract. It did not retract, so it was scooped up with a knife and placed in a jar of water, where it immediately came to life. The specimen remained alive for several days before being placed in spirits. It is interesting to note that, when first picked up, the specimen had its foot edges curled up to the pallial rim, and the underside was an exact caste of the depression in the sponge.

This species is very similar to all species of the genus *Goniodoris* Forbes and Goodsir (1839), but in being smooth-skinned it is easily differentiated. Although the genus *Goniodoris* is known to occur in New Zealand, this is the first record from Australia.

HALLAXA INDECORA (Bergh)

Halla indecora Bergh, 1905, *Siboga-Exped.*, Monogr. 50, p. 116, pl. 15, fig. 3-6.

Small, length up to 11 mm. Dorsal surface smooth, although velvet-like in appearance when alive. Rhinopore-clavus bulbous, perfoliate, with 5 or 6 laminae, retractile. Branchiae 10 in number, simply pinnate, retractile and in a complete circle surrounding the anus. Foot narrow, very deeply sinuated anteriorly, the extended corners possibly acting as orals. No projecting head and no oral tentacles. The mouth has two darker patches above it in the form of an inverted V—these, perhaps, are degenerate orals. Body-colour pale yellow, rhinophores and branchiae similar in colour. Radula not examined; Baba (1949) states, after examining two specimens, "18 x 6.1.0.1.6 and 20 x 7-8.1.0.1.7-8. First lateral large and broad, bicuspidate at tip. All succeeding laterals narrow and knife-shaped, with a series of 9-11 denticles on the edge." O'Donoghue (1929) describes a radula with teeth corresponding to those stated by Baba above, but says that there are 33 rows of teeth, 7.1.0.1.7.

Locality: Torquay (1 spec., Jan., 1958).

Station: Rare, crawling on a specimen of the echinoderm *Halopneustes inflatus*, although it is quite possible that it had just crawled on to this from surrounding seaweed.

Remarks: A most remarkable small doridiform animal easily indentified by the lack of orals and a sinuate foot. The pale colour is apparently unusual, normal colouring being in the grey or red-purple groups. This species is recorded from the East Indies, the Red Sea from Suez and Aden, Japan, and now Australia.

ROSTANGA HARTLEYI sp. nov.

(Pl. 2, fig. 12-13; text fig. 5)

Up to 40 mm. in length and 20 mm. in breadth. Body-shape roughly rectangular, with rounded corners, somewhat narrower at about half its length. Mantle covered everywhere with closely-set villous papillae as in *R. arbutus* (Angas); but here the papillae are much finer, slender, longer and closer together. Rhinophores clavate, perfoliate, with 7 or 8 large laminae, retractile; rhinophore-sheaths large. Branchiae 10 in number, bipinnate, set in a complete circle around the anus; retractile within a large circular cavity. Branchial-cavity with a very large sheath, margin finely crenulate. Head small, not prominent; orals very long and slender. Foot broad, flat, thickened and nearly square anteriorly; upper lamina deeply notched. Body-colour pale pink or buff, with 3 to 5 large brown patches on either side of the median line; each patch encircled by a faint ring of white papillae. Rhinophores and branchiae white tipped. Radula formula 22 x 18—22.0.18—22. First lateral simply hamate without denticles;

Text fig. 5.
Rostanga hartleyi sp. nov.
A—detail of rhinophore.
B—half row of radula;
a—inner lateral,
b—median laterals,
c—outer laterals.

succeeding 12 laterals hamate, with a series of 3 denticles on the inner edge of each; outermost laterals slender, very closely set.

Localities: Sutherlands Bay, Phillip Island (3 spec., Jan., 1957); Flinders (2 spec., Dec., 1955); Torquay (2 spec., Sept., 1957); Breamlea (1 spec., Jan., 1958, type locality).

Station: Not common, under stones and crawling on seaweed in rock pools at low tide.

Remarks: Very similar to *R. arbutus* (Angas), but the points of difference are consistent. These differences can best be seen by the following key to the two species:—

R. arbutus (Angas).

1. Small body, flat in section, 30 mm. or less in length, breadth more than half length.
2. Rhinophores with numerous small laminae.
3. Head with short digitiform orals.
4. Radula 60 x 50-60.0.50-60; inner lateral finely denticulate, succeeding laterals simply hamate.

R. hartleyi mihi.

1. Large body, convex, over 30 mm. in length, breadth equals half length.
2. Rhinophores with 7 or 8 large laminae.
3. Head with very long orals.
4. Radula 22 x 18-22.0.18-22; inner lateral simply hamate, succeeding laterals denticulate.

It would appear as though *R. hartleyi* is the Flindersian representative of this genus. The author has in his possession a single specimen of this species collected at Coobowie, South Australia, by Mrs. T. W. Hartley of Melbourne, after whom the species is named.

ALLOIODORIS NIVOSUS sp. nov.

(Pl. 2, fig. 14; text fig. 6)

= *A. marmorata* Burn, 1957, *J. Malac. Soc. Aust.*, No. 1, p. 19, non Bergh, 1904.

Body-shape broadly elliptic, length up to 30 mm. and width up to 22 mm., rather flat. Dorsal surface entirely covered with minute spiculate papillae making it coarse to the touch and matt in appearance. Mantle much broader than foot, margin subcrenulate. Rhinophores clavate, finely perfoliate, retractile within low-sheathed cavities which have crenulate margins. Branchiae 7 in number, tripinnate, retractile within a broadly-oval transverse aperture; surroundng anus. Foot narrow, anteriorly notched and grooved. Head large, rounded; orals digitiform. Genital orifice large, appears as a longitudinal slit, situated a little behind the line of the rhinophores. Body-colour pure white, sometimes margined with brown; a number of dark brown spots on the sole, underside of mantle and sides of foot. Rhinophores brown; branchiae white, tipped with brown. Radula formula 37-40 x 18-19.0.18-19. First lateral quite large, a very strongly-curved spine on a short base. Median laterals larger, spines gradually decreasing in size towards the outside. Outer laterals falciform, not denticulate, and much smaller than inner laterals. Labial armature weak, but there is a large, strong oral cuticle.

Localities: Portarlington (many spec., 1954-1956); Sutherlands Bay, Phillip Island (6 spec., Jan., 1957); Shoreham (1 spec., Nov., 1957; type locality).

Station: Common under stones between tides, usually in muddy positions.

Remarks: The body-colour in some specimens is light grey, dorsally darker; mantle with numerous dark brown ring-like circles, in the centre of which is a pure white spot.

Text fig. 6.
Alloiodoris nivosus sp. nov.
Half row of radula; a—first lateral, b—typical median lateral, c—outer lateral.

This species has previously been recorded under the name of the Tasmanian species, A. *marmorata* Bergh (1904). Externally some specimens resemble A. *marmorata* as figured by Basedow and Hedley (1905—pl. 8, fig. 1-2). A. *marmorata* Bergh is a much larger species than A. *nivosus mihi*, and has quite a different radula, both in the teeth and the formula, the former being 34-35 x 40-42.0.40-42, with the outer teeth denticulate; the latter is 37-40 x 18-19.0.18-19 without any denticulate teeth.

Apparently A. *marmorata* Bergh is the Tasmanian or true Maugean representative of the genus, and A. *nivosus mihi* the Victorian form. But now arises the question: What is the correct name of the South Australian species recorded as A. *marmorata* Bergh by Basedow and Hedley? O'Donoghue (1924), when describing his species, A. *hedleyi* from the Abrolhos Islands, claimed his species to be identical with South Australian specimens, probably basing his claim on Basedow and Hedley's statement that their specimens did not have denticulate outer teeth. But A. *nivosus* is similiar to A. *hedleyi* in that it has no denticulate teeth, and therefore South Australian specimens have equal claim to either name. Also because the similarity between living Victorian specimens and the figures of those from South Australia is so much so that the author would prefer to use the name A. *nivosus* for the specimens from the Eastern Flindersion Region until, that is, specimens from there can be examined.

PLATYDORIS GALBANUS sp. nov.

(Pl. 1, fig. 6-7; text fig. 7)

Body small, length 40 mm., breadth 24 mm. Body-shape broadly elliptic, rather flat. Mantle leathery to the touch, minutely granular all over; expanded well beyond the foot. Branchiae very large and bushy; quadripinnate 5 in number, with the anus protruding between the rear pair. Branchial cavity margin consists of 5 broad, indistinct valves. Margins of rhinophore-sheaths crenulate. Rhinophores small, clavate; clavus apparently narrower than stalk, perfoliate, with 10 steeply-angled laminae. Oral tentacles digitiform, head rounded. Foot narrow, grooved anteriorly, not extending beyond posterior margin of mantle. Genital orifice large,

at the right-anterior third; male portion protruding from the anterior side; nephroproct on upper anterior side of genital orifice. Body-colour yellow, of a very bright hue; mantle with a few medium-sized white spots. Rhinophores and branchiae chocolate-brown. Radula formula 18 x 30.0.30. All lateral teeth large, simply hamate.

Text fig. 7.
Platydoris galbanus sp. nov.
Single typical lateral tooth of radula.

Locality: Sutherlands Bay, Phillip Island (2 spec., Jan., 1957).

Station: Rare, under a block of "blue clay" in a muddy position at low tide.

Remarks: A beautiful and distinctive species with no congeners in southern Australian waters. A number of species occur in northern tropical waters, and, while all are somewhat similar to the above, none agree exactly with the above description or colour.

JANOLUS HYALINA (Alder and Hancock)

Antiopa hyalina Alder and Hancock, 1854, *Mon. Brit. Nudi. Moll.*, Pt. 6, family 3, pl. 44, fig. 8-12.

Body small, stoutly aeolidiform; up to 17 mm. in length. Entire mantle margin set with 4 rows of closely-set branchial papillae. Branchial papillae roughly ensiform, rather flat, nodulose all round on the upper half; largest medianly in the inner row. Rhinophores with a large nautiloid-like crest between the bases; each is conical-clavate, perfoliate, non-retractile; eyes visible just behind the rhinophores. Anus protrudes posteriorly on the mid-dorsal line of the dorsum, well inside the branchial papillae. Genital orifice large, consisting of a circular pore on the posterior side. From the outer leading edge of this pore arises a short stalk, which has a bulbous distal end. Head small; orals digitiform, at right angles to the mid-dorsal line; mouth a longitudinal slit. Foot broad, flat, slightly hollow on the anterior edge, extending well beyond posterior margin of dorsum into a pointed tail which has a bare crest. Body-colour fawn; dorsum orange spotted. Branchial papillae fawn; ramifications dark brown. Radula not examined.

Locality: Torquay (2 spec., Jan., 1958).

Station: Rare, under rocks in mid-tide pools.

Remarks: Eliot (1910) states that the radula formula is 15 x 11-13.1. 11-13, but his figures of the species differs in some ways to those given by Alder and Hancock in their original description. My specimens agree extremely well with the original description and figures, and therefore I have used the above name in preference to creating a new species.

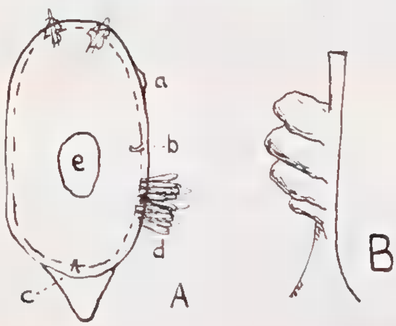
Unfortunately, the correct systematic position of this and the next species are unknown to the author from lack of literature on the subject. Therefore, while the sub-order is known, the super-family and family are left blank until further information is gained.

This and the next species might easily be confused when collected together, but this species, *J. hyalina*, is darker in colouring and has a most distinctive crest between the rhinophores, which the next species lacks. The type locality of this species is Cheshire, England.

PROCTONOTUS? AFFINIS sp. nov.

(Pl. 2, fig. 15; text fig. 8)

Body small, broadly aeolidiform, up to 15 mm. in length. Branchial papillae comprising 4 rows of closely-set, claviform, non-caducous papillae set all round the dorsal margin, including across the tail. Rhinophores claviform, median-part of rear edge set with 4 rows of closely-set papillae, as in *Madrella* Alder and Hancock, non-retractile. Median part of dorsum smooth; a large pericardium is centrally situated a little to the right posterior side. Genital orifice large, on the right anterior side, forward of the pericardium. Anus situated among the branchial papillae on the posterior edge of the dorsum, elevated slightly. Nephroproct(?) on right side, next to pericardium, arises from among inner rows of branchial papillae and faces forward. Foot pale pink, long, rounded and thickened in front and pointed behind, extending posteriorly beyond papillae; crest of tail bare. Head small, no noticeable veil as in other species, but the head-corners are produced slightly into short digitiform tentacles. Mouth typical of the genus. Body-colour reddish-fawn; median part of dorsum orange or red; pericardium vermillion, brighter than dorsum, outlined with yellow; rhinophore-sheaths joined by a yellow patch, which itself is joined to the yellow around the pericardium by a short but broad yellow line. Head pale pink, tail transparent; rhinophores clear, speckled with greenish-yellow spots.



Text fig. 8.
Proctonotus? affinis sp. nov.
A—dorsal view, a—genital orifice, b—nephroproct(?), c—anus, d—papillae, e—pericardium.
B—*detail of rhinophore.*

Branchial papillae fawn, externally speckled with minute red spots, so that they appear reddish, internally dark brown. Radula not examined.

Locality: Torquay (1 spec., Oct., 1956; 6 spec., Oct.-Dec., 1957).

Station: Rather common, under stones at and below mid-tide.

Remarks: At first this species was thought to belong to the genus *Madrella* Alder and Hancock (1864) because the rhinophores are of the same type as that genus. But the positions of the anus and nephroproct, and the shape of the branchial papillae, would not allow for the reception of the species there. The genus *Proctonotus* Alder and Hancock (1846) was originally stated to have the rhinophores linear, the papillae tuberculate, and the papillae not continuous over the posterior part of the dorsum. In

these points this species does not agree, and thus it is only tentatively referred to *Proctonotus* at present.

Unfortunately, as stated for the previous species, the author has been unable to ascertain the systematic position of the species. The dorsal anus is somewhat reminiscent of the doridiform nudibranchs, but otherwise seems quite unrelated to any of the 3 sub-orders, Arminacea, Dendronotacea, and Eolidacea.

DOTO OSTENTUS *sp. nov.*

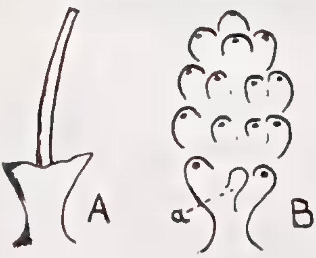
(Pl. 1, fig. 5; text fig. 9)

Body somewhat aeolidiform; small, slender, length 8 mm., breadth without cerata 1 mm. Head a little expanded into a semi-circular head-veil. Rhinophores simple; a long, slender, curved clavus arising from a large, cup-like sheath, the anterior of which is broadly crenulate. Dorso-lateral margins, with 7 pairs of large, non-caducous cerata, each pair being the same size except the last, which is much smaller. Cerata clavate, each ceras with 3-4 circlets of papillose nodules, 6-7 nodules in each circlet, nodules rounded. Branchial fold is in the form of a single horn-like projection on the inner side of each ceras. The anus, which protrudes considerably, is situated dorso-laterally between the first and second cerata on the right side. Body-colour white, everywhere except rhinophores and foot spotted with minute black dots; cerata pink, a black spot on the apex of each nodule and also the apex of each ceras.

Locality: Torquay (2 spec., Dec., 1957; type locality), Flinders (4 spec., May, 1958).

Station: Not rare, under stones in pools at mid-tide.

Remarks: This is the first record of the family Dotonidae from Australia. Rather similar to the type of the genus *Doto maculata* Montagu, but differs in a number of small features about the cerata and colouring.



Text fig. 9.
Doto ostentus sp. nov.
A—detail of rhinophore.
B—detail of single ceras, inner aspect,
a—branchial fold.

LIST OF REFERENCES

ALDER, J., and HANCOCK, A (1844-55)—A Monograph of the British Nudibranchiate Mollusca, *Ray Soc., Lond.*, Pts. 1-7.

ANGAS, G. F. (1864)—Descriptions d'especes nouvelles appartenent a plusieurs genres de Mollusques Nudibranches des environs de Port Jackson (Nouvelle-Galles du Sud), *J. Conchyliol.*, 3e serie, Tome iv, xii, pp. 43-70.

BASEDOW, H., and HEDLEY, C. (1905)—South Australian Nudibranchs, and an Enumeration of the known Australian Species, *Trans. Roy. Soc., S. Aust.*, xxix, pp. 134-160.

BABA, K. (1949)—*Opisthobranchia of Sagmai Bay*, collected by H.M. Emperor of Japan, pp. 194 + 7, pls. 1-50.
——— (1955)—*Opisthobranchia of Sagami Bay Supplement*, pp. 59, pls. 1-20.
BURN, R. F. (1957)—On Some Opisthobranchia from Victoria, *J. Malac. Soc. Aust.*, No. 1, pp. 11-29.
——— (1957)—A New Species of Opisthobranchia from Victoria, *Vict. Nat.*, 74, pp. 115-117.
ELIOT, C. (1910)—A Monograph of the British Nudibranchiate Mollusca, *Ray Soc.*, Lond. Pt. 8, Supplementary.
O'DONOGHUE, C. H. (1924)—Report on Opisthobranchiata from the Abrolhos Islands, Western Australia, *J. Linn. Soc.*, Lond. Zool. xxxv (or No. 237), pp. 521-579.
——— (1929)—Report on the Opisthobranchiata, *Trans. Zool. Soc.*, Lond, 22, No. 6, pp. 713-841.

EXPLANATION OF PLATES.

Plate 6.

1. *Elysia furvacauda sp. nov.*—dorso-lateral view.
2. *Palio parvula sp. nov.*—dorsal view.
3. *Palio parvula sp. nov.*—ventral view.
4. *Paliolla cooki* (Angas)—dorso-lateral view.
5. *Doto ostentus sp. nov.*—lateral view.
6. *Platydoris galbanus sp. nov.*—dorsal view.
7. *Platydoris galbanus sp. nov.*—head.

Plate 7.

8. *Lamellidoris maugeansis sp. nov.*—dorsal view.
9. *Lamellidoris maugeansis sp. nov.*—ventral view.
10. *Goniodoris meraculus sp. nov.*—dorsal view.
11. *Goniodoris meraculus sp. nov.*—ventral view.
12. *Rostanga hartleyi sp. nov.*—dorsal view.
13. *Rostanga hartleyi sp. nov.*—head.
14. *Alloiodoris nivosus sp. nov.*—dorsal view.
15. *Proctonotus? affinis sp. nov.*—dorsal view.

ADDENDA

The missing names from the systematic list at the beginning of this article should be as follows:—

Sub-order - - - - - Arminacea.
Super-family - - - Pachygnatha.
Family - - - - - - **JANOLIDAE.**
**Janolus hyalina* (Alder and Hancock).
**Proctonotus? affinis sp. nov.*

The author can see no reason for the use of the family name Antiopellidae as Odhner (1939) has used. *Antiopella* was proposed by Hoyle (1902) to replace *Antiopa* Alder and Hancock (1848), which was already in use. *Antiopa* was proposed to replace *Janus* Verany (1844) which itself was pre-occupied. In 1884 Bergh proposed *Janolus* for a species with huge jaws, a feature which probably is only a specific difference between *Antiopa spp.* and *Janolus spp.* Therefore, the author has used the family Janolidae in preference to Antiopellidae.

—Robert Burn.

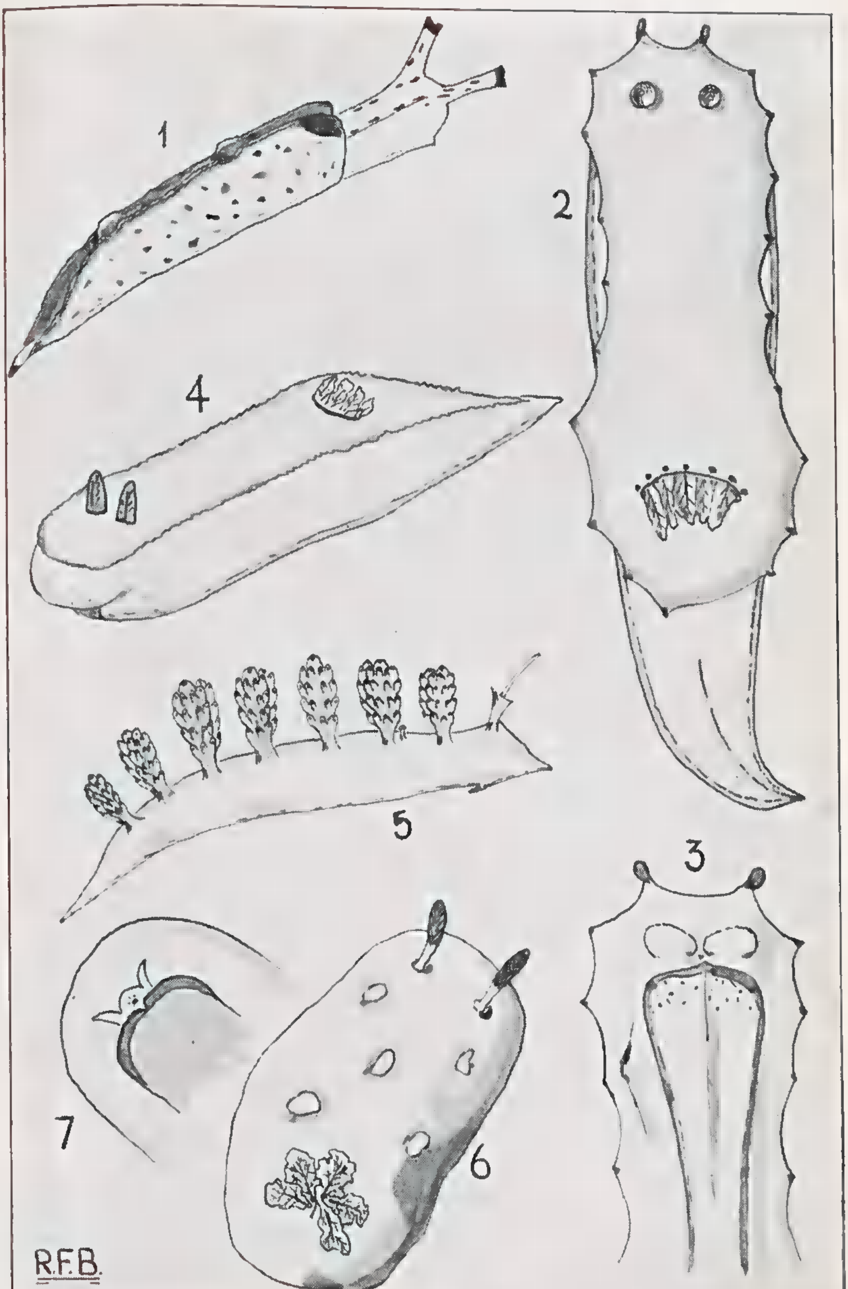


Plate 6.

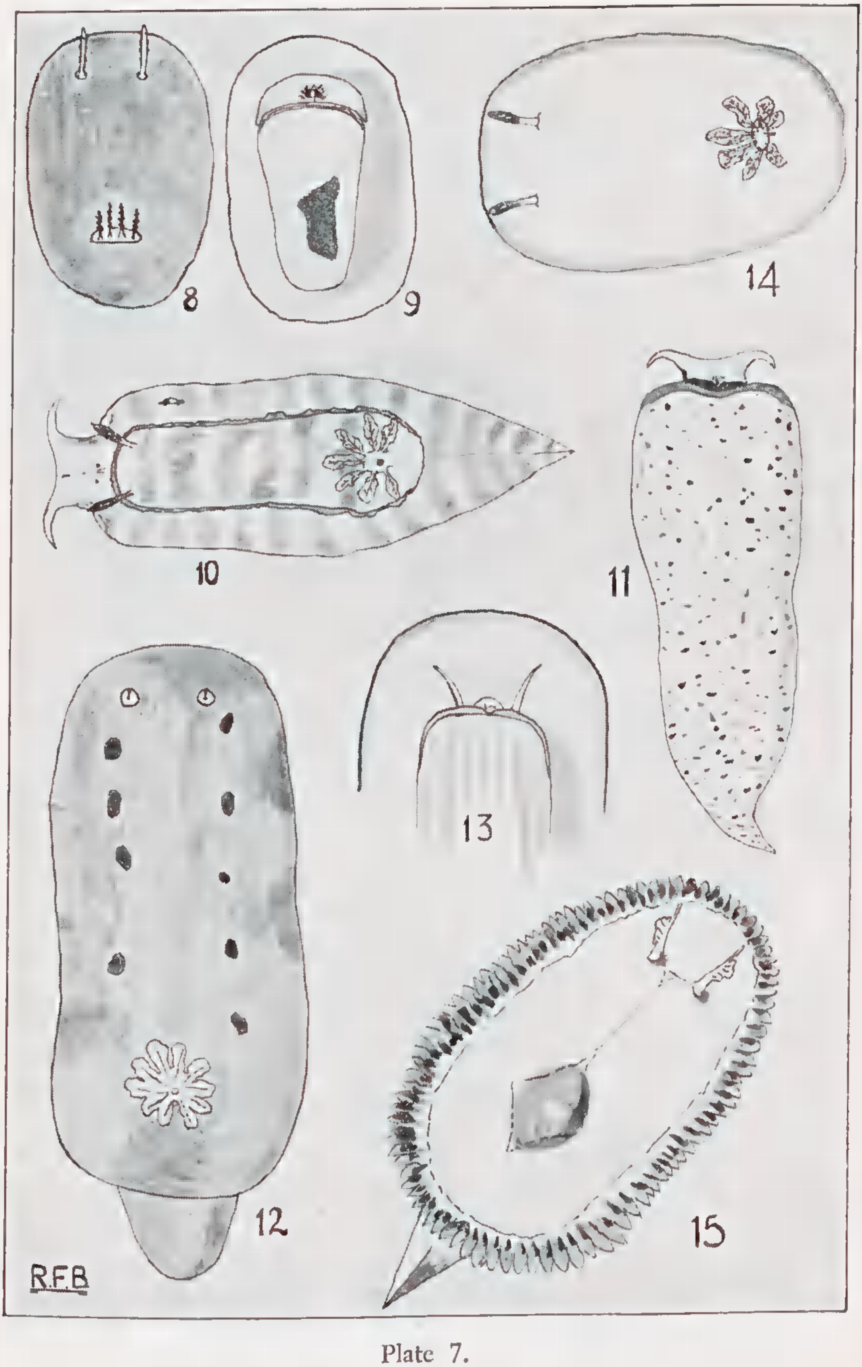


Plate 7.

MOVEMENT BY COMMENSAL *HIPPONIX CONICUS* (Schumacher)

by THELMA HARTLEY*

(Plate 8)

On 10th March, 1958, three dozen *Haliotis ruber* Leach were collected at Flinders, Victoria, Australia. On the majority of these shells the common Victorian limpet,† *Hipponix* (= *Sabia*) *conicus* (Schumacher) was attached. It is not unusual to find this limpet attached to a rock, dead shell, or the back of a live shell. However, it is unusual to find evidence of migration by this limpet. Fifteen of the *H. ruber* with *H. conicus* on them showed that this limpet had definitely changed position. Four specimens are used to illustrate this.

Figure 1.—In this specimen the trail of the *Hipponix* is on the marginal side of the tremata, and the limpet lies at the margin of the *Haliotis*. As with the other specimens, the limpet has its anterior margin at the anterior margin of the *Haliotis*. On the *Hipponix* is a young specimen 3 mm. wide.

Figure 2.—The trail left by the *Hipponix* begins half-way between the apex and the tremata; it extends to the latest formed trema, then follows the trematal line to the margin. At first the trail is only 2 mm. wide, and gradually widens until it is the width of the *Hipponix* shell (11 mm.). The trail is over 3 cm. long, and slightly recessed, the radial rugae and spiral striae being scarcely distinguishable thereon.

Figure 3.—The trail is smooth and gradually widens as in fig. 2. This trail is 8 cm. long, with an obscure beginning. The trail is of such age that there has been time for epiphytic plants and worm tubes to grow on it. The course of the trail is along the apical side of the tremata, i.e., it is spiral like the shell itself. The *Hipponix* shell is now at the margin, and measures 1.8 cm. in width.

Figure 4.—This is a large *Haliotis* (maximum diameter 10.8 cm.) with a trail having a maximum width of 2.3 cm.; it follows the apical side of the trematal line, and the older half is buried under epiphytes. The *Hipponix* has its anterior margin on the anterior margin of the *Haliotis*. On the anterior margin of the *Hipponix* is another *Hipponix* shell nearly 12 mm. wide, and with a clear trail 1 mm. long, the rest being less distinct. On this shell is a still smaller one only 4 mm. wide and situated at the anterior margin.

Comment: The trails are smooth because the *Hipponix* shells have interfered with the deposition by the periostracum. However, as the anterior margin of the *Hipponix* is curved, it is clear that some at least of the surface structures have been destroyed after deposition. In some places there appears to have been some secondary deposition.

The trails are tapering because the *Hipponix* has increased in diameter during its slow movement. The limpets are always at the anterior margin of the *Haliotis*, and so apparently always stay there. The rate of movement is therefore presumed to be the rate of growth of the shell margin.

The *Hipponix* shells, whether on older *Hipponix* or on *Haliotis* shells, are at the margin, and have their anterior margin to the anterior margin of the shell on which they rest. There must be some advantage for this to be the orientation preferred without exception. Supply of food and better oxygenation may be the reasons.

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† "Bonnet limpet" Allan, J. (1950) Aust. Shells, p. 86.

* Melbourne, Australia.

Plate 8.

A NOTE ON THE *MICROTIS* IN AUSTRALIA

By ROBERT TALMADGE*

(Plate 9)

The apparent scarcity of Australian records of specimens of the genus *Microtis* A. Adams, is the basis for this short note. Pilsbry, and others have placed this group, between the *Stomatia* and *Gena* in their systematic treatment of the family Stomatellidae. At the present time, too few specimens of shell, or shell and animal in combination, are available to the writer to do other than mention the finding of this genus in Australian waters.

A number of years ago, the writer received a sending of Haliotids from Mr. Tony Marsh, of Rockhampton, Queensland; which included a single example of *Microtis heckliana* Crosse. These had been collected in the Capricorn Group as a population series for a compartive project. The *Microtis* had been included due to the strong similarity to juveniles of certain Haliotids.

As little information appears to be in the records concerning this species, it is hoped that this note will stimulate interest, and that other collectors will watch for and preserve both shell and animals when found. No published records could be found for this genus in Australian waters. To assist, the following information is given:—

Microtis heckliana Crosse, *J. Conchyliol* 1871, Noumea, New Caledonia. The subcircular shell is extremely thin and fragile, with the spire almost completely depressed into the dorsal surface. The flatish dorsal surface is in contrast to the well-rounded ventral portion, meeting at an acute angle at the periphery of the whorl. Between the sharply incised suture and the periphery of the shell on the dorsal surface, there are a number of low rounded lamellae that radiate outward from the suture to a series of low rounded nodes. The interior of the shell is silvery nacerous. Due to these low nodes there is a superficial resemblance to juvenile Haliotids, with their closed forams. The coloration of the specimen examined was a dull green-white on the dorsal surface, with rusty maculations at the periphery. Ventrally the colour was light green and white in serrate wavy lines.

This does not match the colour or colour pattern as given by Pilsbry in his *Manual of Conchology*, Vol. XII.

However, one of the features noted in this family, Stomatellidae, has been the varied coloration and colour pattern within a species. Thus, it is probably possible to find specimens of various colours and with a number of combinations of patterns.

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* Willow Creek, California.

Plate 9.

Microtis heckliana Crosse, Capricorn Group, Queensland, Australia. Collected by Tony Marsh in 1955. Actual size: Major diameter, 16.50 mm.; minor diameter, 12.00 mm.; height, 5.00 mm.

A NEW TREE-SNAIL FROM NORTH QUEENSLAND

By DONALD F. McMICHAEL, Ph.D.*
Curator of Molluscs, Australian Museum, Sydney.

(1 Text figure)

The tree-snails of the subfamily Papuininae (family Papuinidae of Iredale 1938) are among the most conspicuous members of the land molluscan fauna of New Guinea, the islands of the Bismarck Archipelago and the Solomon Group. It is an interesting fact that comparatively few species of this group have reached Australia, despite the intermittent land connection between New Guinea and the Australian mainland which existed during Tertiary time. Iredale's Basic List of the Land Mollusca of Australia includes eleven species referred to the Papuininae, and another has been added since (*Meliobba shafferyi* Iredale 1940).

Among these is *Rhynchotrochus poiretianus* (Reeve) 1852, which is the type species of the subgenus *Noctepuna* Iredale 1933. There seems to be no good reason for continuing the association of *poiretiana* with the predominantly New Guinea genus *Rhynchotrochus*, so that *Noctepuna* is here used as a full genus. Clench (1943) recorded this species under the name *Papuina gartneriana* Pfeiffer 1851, regarding *poiretiana* as a synonym. However, the two are almost certainly distinct species, for the original description of *gartneriana* by Reeve (whose descriptions of both species antedates Pfeiffer's) mentions plicate striations and a purple-violet blotch on the umbilicus and columella margin of the lip, neither of which are found in *poiretiana*. The correct locality for *gartneriana* appears to be the Aru Islands as Tapparone Canefri (1883) suggested, for specimens in the Australian Museum from that locality agree exactly with Reeve's description.

Reeve gave the locality of both *gartneriana* and *poiretiana* as Port Essington, but Cox (1868, p. 67) showed that *poiretiana* was in fact collected at Night Island, off the north Queensland coast by Macgillivray during the voyage of the "Rattlesnake." The discovery of the species is recorded by Macgillivray 1852, p. 116.

When erecting *Noctepuna for poiretiana* Reeve, Iredale also included *Papuina nuensis* (sic) = *P. muensis* Hedley 1912. However, in his Basic List, Iredale (1938) listed the latter species under *Posorites* Iredale 1933, the type species of which is another Australian tree-snail, *Helix fucata* Pfeiffer. The latter generic placement of *muensis* is undoubtedly an error, for both *poiretiana* and *muensis* are subspecies of a polytypic species which occurs on the mainland on Cape York Peninsula. Specimens of the mainland race were recently forwarded to the Australian Museum by Mr. J. L. Wassell, of Silver Plains Station, near Coen, North Queensland, and as this is not yet named, it is described as new below.

Noctepuna poiretiana clenchi ssp. nov.

Shell trochiform, of 6½ whorls regularly increasing, the whorls slightly convex, the suture shallow. Body whorl rounded below, descending a little at the mouth, not constricted behind the aperture. Mouth oblique, oval, the peristome slightly expanded above, but not reflected; becoming reflected

* Sydney, Australia.

towards the outer edge of the lip and increasingly so below; towards the columellar, the lip expanded and reflected, almost covering the narrow umbilicus. A thin callus joining the margins of the aperture across the body whorl.

Protoconch of 1¼ whorls, not sculptured, but with an eggshell-like appearance under the microscope. Remainder of shell sculptured with fine radial growth lines.

Colour white, the body whorl marked with a dark brown band about 1 mm. in width, usually bordered below by a fine reddish-brown line; the band just below the level of the suture, not showing above the body whorl. Columella marked with a small brown spot.

Animal dark grey, the tentacles reddish-brown.

Type locality: Dinner Creek, at the foot of a spur of the McIlwrath Range, on the Coen to Port Stewart Road, North Queensland.

Types: The holotype is in the Australian Museum, Registered Number C.62421, and is figured on plate 10, figures 1-3. Paratypes are in the Australian Museum C.62422, and additional paratypes are in the Museum of Comparative Zoology, Cambridge, Mass.

Records: Clench (1943) recorded specimens of "*Papuina gartneriana* Pfeiffer" from Lankelly Creek, McIlwrath Range, which are probably this subspecies. Some specimens in the Australian Museum from Coen River are larger, but otherwise agree with *N. p. clenchi*. Mr. Wassell informs me that he has also taken the species at Merluna Station, about 100 miles north-west of Coen, and also from Port Stewart, Princess Charlotte Bay.

Habitat: The specimens were taken from branches of trees in thin marginal scrub along the banks of Dinner Creek, on the 16th July, 1958.

Dimensions (in mm.)

	Length	Maximum Diameter	Minimum Diameter
N. p. poiretiana			
Mean of 20 Topotypes	24.25	19.7	17.5
N. p. clenchi			
Holotype	19.0	16.5	14.0
Mean of 20 Paratypes	18.5	17.0	14.25
N. p. muensis			
Holotype	15.0	14.0	12.5
Mean of 4 Paratypes	13.0	12.25	12.0

Distinguishing Characters and Relationships: The new subspecies stands intermediate between the other two subspecies, *poiretiana* and *muensis*. *N. poiretiana poiretiana* Reeve is larger, and lacks the broad dark band of *clenchi*, in place of which it has a fine reddish-brown line only. The shell is normally cream coloured, not flat white as in *clenchi*. On the other hand, *N. p. muensis* Hedley is much smaller than either *poiretiana* or *clenchi* and is proportionately broader. *N. p. muensis* agrees with *clenchi* in possessing the dark, broad band, but differs in the general colour of the shell, which is light brown or buff.

N. p. clenchi appears to be rather widely distributed in the lower part of the Cape York Peninsula, and probably occurs throughout the Peninsula, as it has probably given rise to the *muensis* subspecies, which is known only from Mua or Banks Island in Torres Strait. It has probably also been the ancestral source of *N. p. poiretiana*, which is known only from Night Island.

The new subspecies is named in honour of Dr. William J. Clench, Curator of Molluscs at the Museum of Comparative Zoology, who with Dr. R. D. Turner is revising the Papuininae. Specimens of N. *p. clenchi* have been sent to the Museum of Comparative Zoology for anatomical study.

REFERENCES.

CLENCH, W. J., 1943—*Nautilus*, 57: pp. 64-66.

COX, J. C., 1868—*Monograph of Australian Land Shells.* (William Maddock, Sydney.)

HEDLEY, C., 1912—*Rec. Australian Mus.*, 8: pp. 154, pl. 54, figs. 44, 45.

IREDALE, T., 1933—*Rec. Australian Mus.*, 19: pp. 41-42.

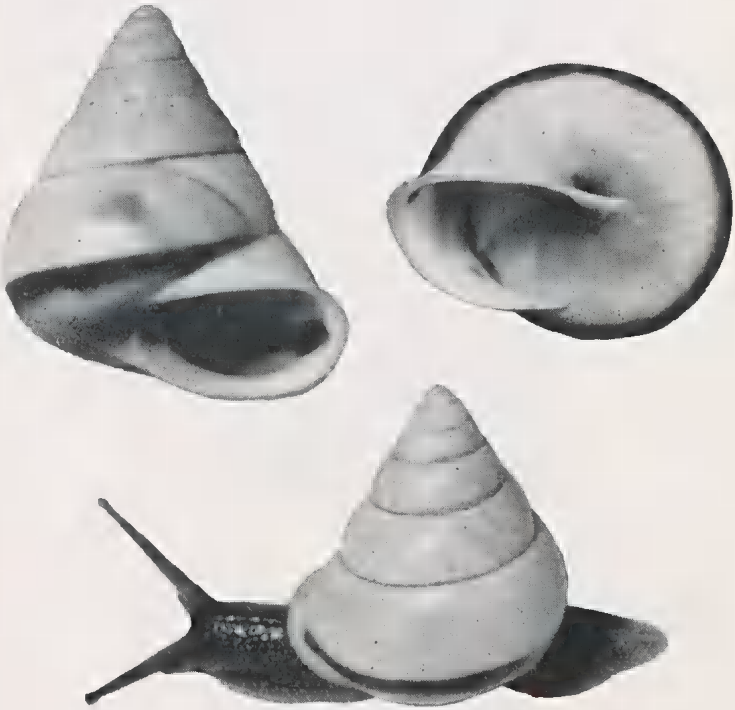
———— 1938—*Australian Zoologist*, 9: pp. 91-93.

———— 1940—*Australian Naturalist*, 10: pp. 239-240.

MACGILLIVRAY, J., 1852—*Narrative of the Voyage of H.M.S. Rattlesnake*, Vol. 1.

REEVE, L., 1852—*Conchologica Iconica*, 7: Helix, pl. 79, sp. and figs. 418-419.

TAPPARONE CANEFRI, C., 1883—*Ann. Mus. Civ. Stor. Nat. Genova*, 19: pp. 129-131.



Text fig.

Top left—ventral view of Holotype.
Top right—umbilical view of Holotype.
Bottom centre—left dorso-lateral view of shell and animal of Holotype.

CYMBIOLA SOPHIAE (Gray), FROM THE ARAFURA SEA.

By TAKASHI OKUTANI.*

(2 Text figures)

A single specimen of a beautiful Volute, *Cymbiola sophiae* (Gray) was brought back from the Arafura Sea by Mr. Takemura, biological investigator for the Tokai Regional Fisheries Research Laboratory during 1957, when he was in charge of pearl fishing. It was collected alive from the muddy bottom of the pearl fishing ground near Thursday Island at a depth *ca.* 25-35m. Though the present writer has examined several specimens of this species, collected from the Arafura Sea, before he was supplied with this specimen, it was his first opportunity to see the shell with animal. However, the visceral part was unfortunately lost.

CYMBIOLA (*VESPERTILIO*) *SOPHIAE* (Gray).

Voluta sophiae Gray, 1864, *Ann. Mag. Nat. Hist.*, xviii: 431 (*cit.* Tryon 1882, *Man. Conch.* IV.: 87).

Shell of medium size, elongate in shape, 6 cm. in height, stout; surface smooth, shiny; spire low, obtuse at the apex, encircled with spines with interspaces around the shoulder; spines short but acute, directed upwards, 10 in number on the body whorl, 6 on the penultimate whorl; protoconch followed by low spire bearing primitive and weak axial ribs, suture shallow, indistinct, not channeled, aperture narrow above, angular at the shoulder, broadly round below; outer lip simple, acute at the edge but somewhat thickened at the shoulder; columellar margin thickly calloused at base and provided with 5 strong and oblique folds; canal rather deeply sinuous dorsally; no operculum.

Coloration of the shell, light chestnut brown generally, with pale maculations here and there; body whorl girdled by two darker zones with brownish black spots of various size sparsely and irregularly arranged along the edges of darker zones; area between the suture and shoulder provided with axial brown striae; brown fine striae also around the columellar callous; aperture pinkish brown inside, gradually becoming darker towards marginal area of outer lip. Foot massive, broad in general; the dorsal surface rather rough, gray in colour with four transverse bands of yellowish gray and spotted with ashy white; epipodium smoothly round at the edge, slightly projected laterally, with fine delicate mammillar papillae along the marginal part; pedal sole smooth, broad, yellowish gray in colour with fine transverse lines; metapodium with blunt end. Cephalic tentacles rather short, obtuse at the tip, flattened, gray in colour. Siphon long, tube-like in shape, gaping along the ventral side, gray in colour with darker maculations; proboscis short in the fixed position. Mantle observable beneath the shell, yellowish white, but spotted with gray and yellow along the margin.

Remarks: Such workers as Tryon considered this species to be a form of "*Voluta*" *norrisi* Gray. And yet, this species is closely allied to *C. vespertilio* (L.) in every external feature. This species is distinguished from *C. vespertilio* by less elongate shape, more angular shoulder, more acute spines, lower spire, broader aperture and pale coloration or colour pattern. The shape of the foot of *C. vespertilio* figured by Tryon (1882, *Man. Conch.*

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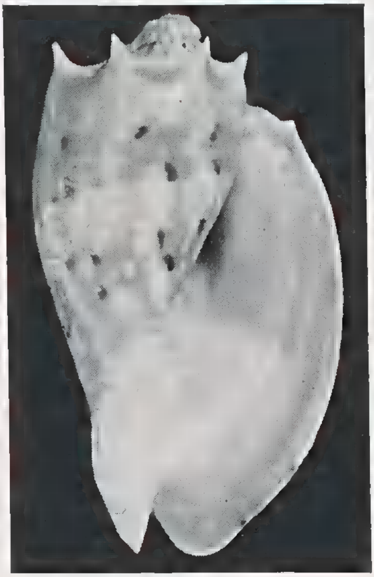
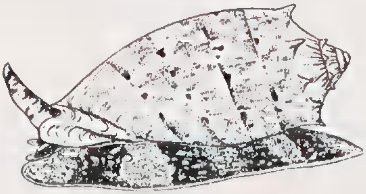
* Tokai Regional Fisheries Research Lab., Tokyo, Japan.

IV, pl. 25, fig. 48; cited from Quoy, 1832, *Voy. Astrol.*, t. 14, fig. 3) is slightly different from that of this species in having a sinus of the lateral margin between the epipodium and mesopodium. But the present author is of the opinion that this may be rather exaggerated, as the epipodium usually projects laterally a little in such related Volutes as *Fulgoraria*, which has a bright reddish foot. Ecologically, this species seems to live buried in the muddy bottom, like other Volutes and their kin, *Melo*.

From the Arafura Sea, two other Volutes were also collected. They are *Volutoconus bednalli* (Brazier) and *Amoria turneri* (Griffith and Pidgeon). The former is extremely rare in the area, as only three specimens have been examined by the writer, while the latter is said to be rather commonly found in the pearl fishing grounds. This has been reported along with other shells from the Arafura Sea by Takemura and Okutani (1955, *Bull. Jap. Soc. Sci .Fish.*, 21 (2)), in which a part of the molluscan fauna in the "East" pearl fishing ground of the Arafura Sea was roughly summarized.



Text—figure 1.



Text—figure 2.
Cymbiola sophiae (Gray) collected from the Arafura Sea near Thursday Island.

ZOILA ROSSELLI Cotton

By THELMA HARTLEY*

(1 Text figure)

Zoila rosselli was originally described in 1948. In this article Mr. Cotton said the only specimens known were six taken by Mr. Rossell at Fremantle, Western Australia, with a possible seventh from Cottesloe, a beach just out of Perth and very near Fremantle. (According to information received by the author from various sources, there would appear to be twelve specimens in existence.)

Four of these shells belonged to Mr. W. R. Steadman, one of which was donated to the Adelaide Museum, which is the holotype specimen figured in five different positions. A broken specimen belonging to the series is also figured to show the interior structure.

In Mr. Cotton's *Remarks* he said: "The species is constant in character, size and shape. Only three distinct species and four sub-species of the primitive cold water cowries belonging to the genus *Zoila* are known, and they are found in Western and South Australia. There are four Tertiary species in the Miocene of Victoria, *Z. consorbrina* McCoy 1877, *Z. platypyga* McCoy 1887, *Z. simplicior* Schilder 1935, and *Z. toxorhyncha* Tate 1890. None of the Tertiary species resembles the recent one here described. Probably *Z. rosselli* is more closely allied to *Z. decipiens* Smith 1880, described from north-Western Australia than to any other species, but it is distinct."

Mr. Cotton points out the fact *Z. rosselli* differs in the flattened base with its spreading and sharply-edged margin and coarse spaced teeth of the columella and outer lip. Curiously, *Z. rosselli* has the general shape of *Siphocypraea mus* Linne 1758 Mediterranean, and of *Bernaya teulerei* Cazenavette 1846 Arabia, and *Bernaya fultoni* Sowerby 1903 Natal, but these three species have well-rounded bases and *Bernaya* is edentulous. *Syphocypraea* has a complete set of spaced teeth on the margins of the wide aperture, a feature which in some way recalls *Z. rosselli.*

Mr. Rossell took the shells from a beach near North Wharf just beyond the wall where all sorts of rubbish came ashore. The bucket dredges dumped their contents straight out to sea opposite this beach, which means the shells may have come from the bottom of the harbour.

Mr. Rossell wrote: "I remember small stones, some with shells such as *Turbo setosus* stuck in them in a partly fossilised state. . . . I often picked up immature *C. scotti* on this little beach, but of course *scotti* were, and some actually had the remains of the animals in. . . . If I remember, the time would be about October, after the equinoctial blows of September . . . it must be a long time since I took them, at least 30 years ago. I remember it very well, and the dorsum was pale brown, somewhat marked with tiny scratches and cleaned at once with the application of hydro-chloric acid. I imagined then that it effected an improvement in the shell's appearance, but I was just beginning to collect things and, had it been recently, I would have known better."

These shells, taken by Mr. Rossell over 40 years ago, have never been duplicated by any collector, and have changed hands only rarely. Although in Mr. Cotton's opinion, the specimens were dead when taken, and in spite of the fact acid was used on the dorsum, they remain beautiful specimens. The caramel-brown of the base, with darker brown spots showing through; the wavy left margin edge and the sharply humped dorsum all create an attractive effect. A truly outstanding shell.

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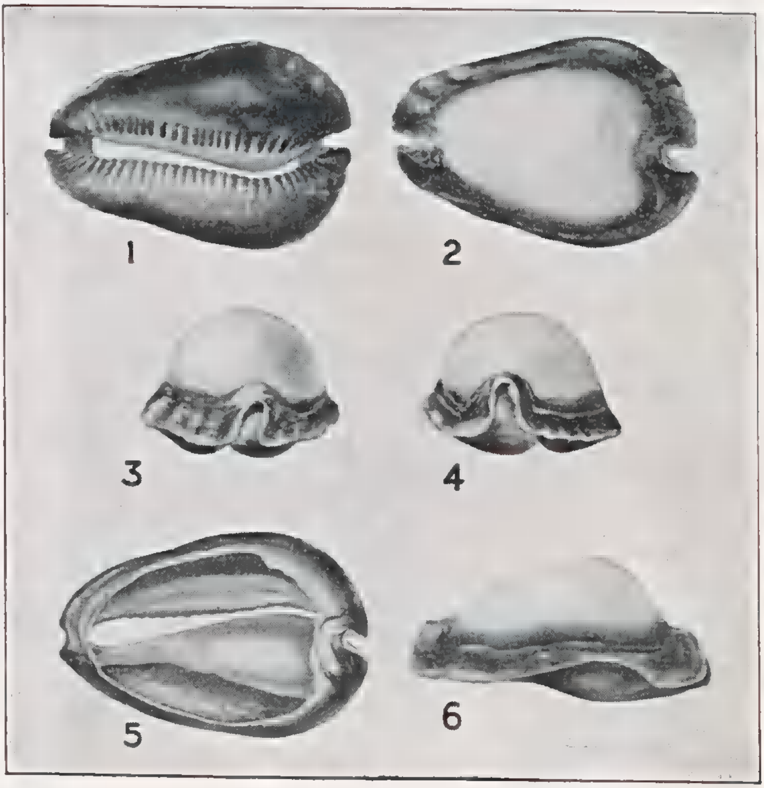
* Melbourne, Australia.

At present these twelve shells are in the following collections: The South Australian Museum in Adelaide has the holotype; the National Museum of Victoria has, so I have been given to understand, one specimen; according to information received, the Cottesloe specimen is in the Australian Museum of Sydney; these is one *rosselli* in the private collection of Lt.-Col. R. J. Griffiths of Melbourne (this is the broken specimen pictured below, showing the pearly white interior); two specimens collected at Leighton Beach by Mr. Rossell are in the Western Australian Museum, along with two specimens "presented by West, unknown locality and unknown collecting data, but may have been collected by Rossell"; one specimen is in the West Australian Naturalists' Club, collected by G. Kendrick at Leighton in 1955; one is in a private collection in the United States, having been sold recently by a Sydney shell dealer; and there are two Z. *rosselli* in the Hartley collection.



Text figure 1.

Zoila rosselli Cotton 1948

Fig. 1—*Zoila rosselli* ventral, holotpye.
Fig. 2—*Zoila rosselli* dorsal, holotype.
Fig. 3—*Zoila rosselli* anterior, holotype.
Fig. 4—*Zoila rosselli* posterior, holotype.
Fig. 5—*Zoila rosselli* dorsal aspect of broken specimen showing interior.
Fig 6—*Zoila rosselli* lateral, holotype.

SOME SPECIES OF LAMELLARIIDAE (Class Gastropoda) FROM THE EASTERN AUSTRALIAN COAST

By JOYCE ALLAN.*

(Plates 10-12)

In presenting this paper I have purposely refrained from specifically identifying the species, but have confined myself to producing the illustrations coupled to a somewhat full description which should make them recognisable if encountered at any time. My reason for doing this was that some years ago it was my intention to revise the family Lamellariidae, and I prepared intensive descriptions and illustrations of living specimens when they were brought to me. These, however, appeared very rarely, and years went by without further material being collected by myself or friends. The outbreak of World War II, with its depletion of staff and the application to duties of more immediate concern necessitated the dropping of this revision temporarily. The post-war period was even more difficult with lack of staff and rebuilding of the Molluscan room in the Museum and other reasons, so that it only now that I have been able to do further work on this proposed revision. By publishing the species, unnamed specifically, except initially A, B, C, D, they may be of more use to an author who may be revising the group, more so than if I had suggested new names for one or two of them, only to have them possibly found to be no synonomous with other species, for it is my belief at this stage that they should be considered in relationship to species from beyond Australia just as closely as from various localities in Australia.

From New South Wales we have *Marseniopsis inominatus* Iredale 1936, type locality, Sydney Harbour, which Iredale named for Hedley's *M. sp. Lamellaria indica* Angas 1867—Hedley's *Check-list* No. 705, but this does not agree with the four species under discussion. *M. australis* Basedow 1905, is recorded from S. Australia; *Lamellaria ophione* Gray, 1849 (1850) is the only record for Victoria, Tasmania and Queensland. This species is also recorded from Auckland (Type), and S. Australia. Their revision needs critical study of literature and material, even for the genus *Lamellaria* Montagu into which I am placing them, perhaps tentatively, as they appear to have the characteristics of that genus more than others of the family.

The specimens did not stand up to continuous handling, and in the case of one was only semi-alive when first found and already decomposing while being described and illustrated, but nevertheless, the descriptions and illustrations were faithfully done on the living animal.

Superfamily LAMELLARIACEA

Family LAMELLARIIDAE

Genus *Lamellaria* Montagu 1815.

Soft animals somewhat pleurobranch-shaped, carrying a small, thin, whitish and shiny shell internally on the dorsal surface. Surface of animal may be gelatinous, more so in some species than in others, usually pustulose and often with light coloured retractile filaments, at times branched, scattered over it. Foot is usually shorter than mantle, although in some circumstances can extend beyond it posteriorly. Head and foot well formed. The genus

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is mainly known by the few small shells which are only occasionally washed ashore, the animal rarely, if ever seen. The animals are thought to be carnivorous, sexes separate. Type of genus *L. perspicua* Linne.

The animals vary from less than an inch to about two inches or slightly more in size; their shells from below, to approximately an inch, or a little more.

Lamellaria sp. A.

(Plate 10, figures 1-16)

Animal large, almost as broad as long, in some positions quite circular. Very active, gelatinous, especially the undersurface. Mantle has pustulose appearance with fine veining, and two humps on central dorsum with rows of retractile, often branching filaments radiating from them. Some pustulose formation on anterior opening of mantle which turns back. Shell is wholly internal, swollen, white, of shelly texture, with distinct radiating lines. It rests over the viscera, occupying the whole of the central dorsal surface.

On the undersurface, between the mantle and the foot, extends anteriorly the head with conspicuous long eye-bearing tentacles; the eyes are black, situated about 4 mm. from where the tentacles arise from each side of the head. Tentacles and eyes are wide apart and the head neck is fairly long. Mouth is a transverse slit, but a proboscis is exerted when the specimen is placed in spirit, showing a portion of red-brown jaw. The animal was a male and the penis was situated about 7 mm. from the base of right tentacle, non-retractile but curls into branchial cavity when quiesant; flattened, and broad terminally. Two gills are seen on the roof of the cavity; they can protrude somewhat through the branchial opening on the right side below the head.

The foot is about half as broad as animal, with a long, broadened tail, and anteriorly has a double furrow. On the upper anterior portion of the foot, on either side of the head neck, a lower lamina is formed into a rounded flap, and an upper lamina forms two similar but shorter overlying flaps. These do not protrude beyond the foot at all, but seem to lie on it (see Pl. 10, f. 15) attached by a small muscular portion to the foot furrow ends beneath them.

Internally the jaw has a horny, yellow-brown portion like a fish scale, with fine and strong transverse lines; the jaw is a uniform mass with no indication of rods or serrations that I could see. The radula is ribbon-like, part straight, part curled; pale horny. There are 24 rows of teeth, three teeth in a row 1.1.1., consisting of a medium tooth conspicuously toothed laterally, overlapped on either side by a strong lateral tooth.

Colour of the living animal is somewhat similar to that of the sea-hare *Dolabrifera brazieri*, a greenish-brown base, brown speckling between, and with large yellow-orange blotches scattered over the surface. The two humps, also on the dorsal surface are orange red, and the filaments are yellow. Tentacles are yellow speckled, gill creamy, orange-red tipped. Undersurface is creamy yellow with orange tinted edges and white speckling. The foot is pinkish yellow with white splashing and edges with orange tones and orange-brown spots anteriorly. In spirit the animal became grey with the pustules showing at intervals.

Measurements of animal. Animal was 3 inches long and approximately the same width. Shell measured 27 mm x 14 mm. Radula, 15 mm., one-third curled. Jaws, 3 mm x 2.5 mm.

Locality: Gunnamatta Bay, Port Hacking, south of Sydney, N.S.W. Collected M. Ward, January, 1941. Single specimen.

Remarks: When alive, this animal is extremely active, swimming by mantle movement, moving freely and turning over by curling over its foot-anterior to posterior; it also clings by its foot and swings around on an axis until the creature looks like a mushroom on a stalk, but very active indeed, and an extremely attractive marine animal (see Allan, J., *Australian Shells*, 1950, p. 138, fig. 1).

Lamellaria sp. B.
(Plate 11, figures 1-14)

Animal small, almost circular, of humped appearance which did not alter to any extent in preservative. Dorsal surface pustulose almost to warty appearance in spirit, which also made the animal seem solid and tough, rather more so than the living animal. The filaments characteristic of the former species did not show on this species. There was a square cut opening at the anterior end of the mantle, the base of this forms a siphon. Beyond this opening could be seen the long, linear tentacles protruding. The tentacles are interesting. Situated between the foot and mantle as usual, with the eyes half-way along their outer edge, an important difference lies between the position of the eyes in the species from Gunnamatta Bay (previous species), which are well below the base of the tentacles, which in themselves are wide apart and in almost straight line, whereas the Long Reef tentacles form a V at their base, with the eyes half-way down on projecting prominences on their outer edges.

The undersurface has a deep cut furrow leading to the branchial opening, through which the gills (two) protrude: they appear more free and much stronger than in the previous species. They are attached at one side to a cavity, and one of them is attached to the roof of the branchial cavity. The penis is flattened, broad, and of more uniform shape than with the former species. Strong lines cross from inner to outer edge, like corrugations. It protruded from a terminus but did not appear retractile. The foot has a very striking appearance. It is about one-third the width of the animal, broad anteriorly, pointed posteriorly, somewhat leaf-shaped. The foot-sole has a slightly pustulose appearance, which may be due to wrinkling. The anterior end prolongs into two short ears, deeply furrowed, the furrows running down into the ear tips. Upper and lower laminae of anterior end of foot united at each end wing, forming simple furrow. Jaw has fine transverse lines and under very high power fine radiating lines noticed here and there; edges thickened. Radula is ribbon-like, longer than that in the previous species. Twenty rows of teeth are free, the remainder are curled or weak, and formula of teeth I.I.I. Teeth are very strong, larger and stronger than those of previous species, neither were there any serrations on the teeth, whereas in the other species, the teeth serrations stood out conspicuously and the teeth themselves were delicate and smaller.

Colour, reddish-orange, which changed in preservative to creamy pink, with scattered black dots and splashes. Undersurface, foot, tentacles and penis light coloured; gills cream. Jaw light olive green; radula dark horn.

Shell, more globose and shelly than the previous one, and rounded. Horn coloured on upper part of the columella; fine radiating growth lines

with faint suggestion of fine transverse lines. The shell was heavier than the former, with a more elevated spire.

Measurements: Complete animal, 42 mm. in length (and possibly in breadth), 23 mm. in height. Shell: 22 mm. by 17 mm., spire 7 mm. across. Penis was 11 mm. long and 4 mm. wide. Jaw: 4 mm. long, 2 mm. wide. Radula: 15 mm. long, made up of 6 mm. action piece, 6 mm. free straight portion, the remainder was coiled, the radula being 1-2 mm. wide.

Locality: Long Reef, north of Sydney, N.S.W. Collected by M. Ward, 1940, at dead low water.

Remarks: During the very short time this was alive, before it was placed in preservative, it did not display the gymnastic actions of the former species. This species could prove later to belong to a different genus than the previous species. Their differences have a subgeneric ranking, at least, if not generic.

I have seen this species from Bottle and Glass, Sydney Harbour, and one very like it, if not it, from 20-30 fms. off Brush Island, South Coast of N.S.W.

Lamellaria sp. C.

(Plate 12, figures 1-10)

Animal elevated especially in the central dorsum; crawls by pulling itself along in jerks, and when resting looks very like a nudibranch. It did not at any time show tendency to swim, or elevate the mantle as some species do. Foot sometimes extends beyond the mantle posteriorly; it clings by flattening the anterior portion of the foot sole and head to a rock and raising the hind portion of its body right up. Foot curls narrowly when handled. The mantle opens at the anterior end, showing a siphonal groove. The latter is not deep cut as in the previous species, but shallow and wide. The mantle opening referred to above is more V-shaped than squarish. The head tentacles are long and narrow and extend well beyond the mantle anteriorly when crawling. The general texture of the body is inclined to be rather firm and tough, the dorsal surface covered with filamentous pustules, and in the dorsal centre, the most elevated part of the animal, there are a few larger humps forming a more or less ridge. The foot is much narrower than the mantle. The upper end of the foot sole has a gland which acts as a pedal gland and is used to assist its jerky locomotion. Anteriorly, the foot is deeply grooved and at the sides slightly winged. Eyes are below the base of tentacles, on the outer edge.

A female specimen only was collected. Its genital opening was located at lower edge of branchial cavity. There were two dark gills in cavity, one of which seemed double, and the larger single one appeared more free. The mouth showed a delicate, pale, glassy jaw at its entrance, which when examined showed longitudinal lines and fine cross lines. The radula was the usual type, with 18-24 rows of pale teeth, dentition formula I.I.I. meeting to a point in centre, the lateral on either side more or less hiding the median tooth. Shell white, somewhat calcareous, somewhat like the Gunnamatta Bay one. Size, 11 mm. by 13 mm. The illustration in Plate 12 shows its features well.

Colour of the animal is dark greenish grey, with black speckling and spots. The filaments on the dorsal pustules are yellow, making the pustules appear yellow. Foot pale yellow spotted and speckled with darker colour. Undersurface of the mantle is light greyish, with darker grey mottlings, with small subdued black marks in them. Scattered filaments very faintly show through. Head and tentacles bases are speckled dark grey. Jaws are pale horn colour; radula has pale yellow teeth; the ovary is yellow, and the gills very dark, as stated above. In spirit, the general tone became greyish green with darker spots and speckling. The disappearance of most of the yellow colour was due possibly to the shrinkage down of the yellow filaments which are exerted in the living animal. The surface pustules appear small and pointed.

Measurements: Animal, when crawling, 1½ inches long, ¾ inch wide. Shell, as stated above, is 11 mm. by 13 mm.

Locality: Angourie Pool, Clarence River, N.S.W. Found under big rock in deep water. Collected by A. A. Cameron and J. Allan, 6/6/1941.

Lamellaria sp. D.

(Plate 12, figures 11-20)

Animal small, rounded, mantle extended almost twice as far beyond tail tip as it does beyond head; mantle edges very thin, anterior opening in it appears almost like a crenulation, groove shallow. Surface is slightly pustulose. Undersurface shows a squarish head with slight but linear tentacles and eyes well apart at base of tentacles. The lower edge of the anterior foot groove extends beyond sides of foot in short flaps. Gills were not protruding beyond cavity. Jaws are horny and typical. Radula glassy, whitish, 19 rows in use, remainder coiled (slightly longer portion straight, detition formula I.I.I. typical in shape, with faint suggestion of serration on each tooth.

Shell shiny, whitish, calcareous over yellowish spire apex, elongate, spire small but elevated, longitudinal and somewhat wavy lines, with a few spaced transverse ones, especially towards the suture of the body whorl. Both male and female specimens were collected and examined. The specimen from Woody Head was a male and slightly smaller than the female from Angourie Pool. The male shell was small and a perfect little shape, with small spire, and, although most of the calcareous element was patchy, yet the shell remained glassy, firm and opalescent. Female shell was naturally slightly bigger.

The penis of the male specimen was not protruding; it was tucked into the branchial cavity and formed an arched shield, as it were.

Colour: General colour of specimens was light salmon pink with tendency to orange. Specimens seemed immature, and colour of the smaller tended to cream with orange tints and speckled with orange-brown; orange spots appear on dorsal surface, and round the mantle undersurface. Gills were cream, and tentacles cream speckled with orange.

Measurements: Male animal (Woody Head) was only ½ inch long, shell 6 mm. x 4 mm. x 4 mm.; the Angourie specimen, a female, was one inch long, with a corresponding larger shell, 10 mm. x 7 mm. x 9 mm. Tentacles were 3 mm. long and jaw 2 mm. x 2 mm.

Locality: Woody Head (male) and Angourie Pool (female), Clarence River, N.S.W. Collected at low tide, clinging to rock, by A. A. Cameron and J. Allan, June-July, 1941.

Remarks: A female specimen was also collected on sponge at Kirra Beach, Coolangatta, Queensland, and also another male, ¾ inch long. None of the specimens preserved well, and they became very shrunken and colourless, but the rather lengthy descriptions and the illustrations should identify specimens of their kind when found. It is quite possible all the specimens were partly undeveloped, but it is not expected their length would exceed very much more than that of the female mentioned earlier.

REFERENCES.

ALLAN, J., 1936. *Rec. Austr. Mus.* 19, p. 393

——————— 1950. *Australian Shells*, p. 138, fig. 1 (Georgian House).

BERGH, R., 1886. *Semper's Reisen* 2, *Suppl.* 3, pl. 179.

HEDLEY, C., 1916. A preliminary Index to the Mollusca of Western Australia. Extr. *Journ. Roy. Soc.*, I, 1914-15.

——————— 1917. A Check-List of the Marine Fauna of N.S.W., pl. I. *Suppl. Journ. Roy. Soc. N.S.W.*, 51.

IREDALE, T., 1936. *Rec. Austr. Mus.* 19, pp. 267-340.

KERSHAW, R., 1955. A Systematic List of the Mollusca of Tasmania, Australia. Rep. *Papers and Proc. Roy. Soc. Tas.* 89, p. 314.

MACPHERSON, J. H., 1951. A Systematic List of the Marine and Estuarine Mollusca of Victoria. *Mem. Nat. Museum, Vic.* No. 17.

MAY, W. L., 1921. A Check-List of the Mollusca of Tasmania.

POWELL, A. W. B., 1946. The Shellfish of New Zealand. Revis. Ed.

VAYSSIERE, A., 1912. *Ann. Fac. Sci. Marseille* 21, *Suppl.* pp. 113-157.

EXPLANATION OF PLATES.

Plate 10.

Fig. 1. Dorsal view of *Lamellaria sp.* A from Gunnamatta Bay.

Fig. 2. Dorsal view with mantle cut to expose internal shell in situ.

Fig. 3. Anterior portion of undersurface to show mantle with siphonal groove, head with tentacles, mouth, grooved foot and penis protruding at left of neck.

Figs. 4, 5, 6. Three views of gymnastic manoeuvres of animal witnessed before being preserved. Note the free swinging of mantle in relation to foot.

Fig. 7. Jaw of species A.

Figs. 8, 9. Two views of shell after removal from dorsal surface of animal.

Fig. 10. Radula of same species. A number of rows, each composed of three teeth. (Much magnified.)

Fig. 11. A single row of radula teeth consisting of a median tooth flanked on either side by a single lateral tooth.

Fig. 12. Two lateral teeth.

Fig. 13. Median tooth from radula.

Fig. 14. Penis.

Fig. 15. Anterior part of mantle turned back to display head with eye-bearing tentacles, (a) foot flaps, (b) branchial cavity, (c) penis, and (d) siphonal groove.

Fig. 16. Anterior mantle cut and turned back to show (a) mouth with jaw within, (b) bulbus pharyngeus, and (c) radula.

Plate 11.

Fig. 1. Dorsal view of animal *Lamellaria sp.* B., from Long Reef, N.S.W.
Fig. 2. Mantle cut to expose internal shell in situ.
Fig. 3. Undersurface of species showing eye-bearing tentacles, penis on left side between mantle and head, and complete foot with anterior groove terminating in side wings.
Fig. 4. Side view showing normal elevation of animal.
Figs. 5, 6, 7. Views of complete shell, and internal and external view of spire (all magnified).
Fig. 8. Penis of *Lamellaria sp.* B. (magnified).
Fig. 9. Complete radula (magnified).
Fig. 10. Median tooth from radula.
Figs. 11, 12, 13. Lateral teeth from radula.
Fig. 14. Jaw removed from animal, *Lamellaria sp.* B.

Pate 12.

Fig. 1. Side view of *Lamellaria sp.* C., from Angourie, Clarence River, N.S.W.
Fig. 2. Dorsal mantle of same cut to expose shell in situ.
Fig. 3. Head showing eye-bearing tentacles.
Fig. 4. Undersurface of anterior end of mantle showing dark depression which apparently serves as siphonal groove.
Fig. 5. Undersurface of mantle to show branchial cavity in relation to head and upper end of foot.
Figs. 6, 7. Two views of complete shell.
Fig. 8. Jaw of *Lamellaria sp.* C.
Fig. 9. Median tooth from radula.
Fig. 10. Selection of lateral teeth from various rows of radula.
Fig. 11. *Lamellaria sp.* D., from Angourie and Woody Head, Clarence River, N.S.W. (male).
Fig. 12. Anterior view beneath mantle showing head with tentacles, and below the head the front view of foot showing the lateral groove.
Fig. 13. Penis of male.
Figs. 14, 15. Shell of male animal.
Figs. 16, 17. Shell of female (shells and sectional drawings all magnified).
Fig. 18. Jaw.
Fig. 19. Median tooth from radula of female.
Fig. 20. Some laterals from same.

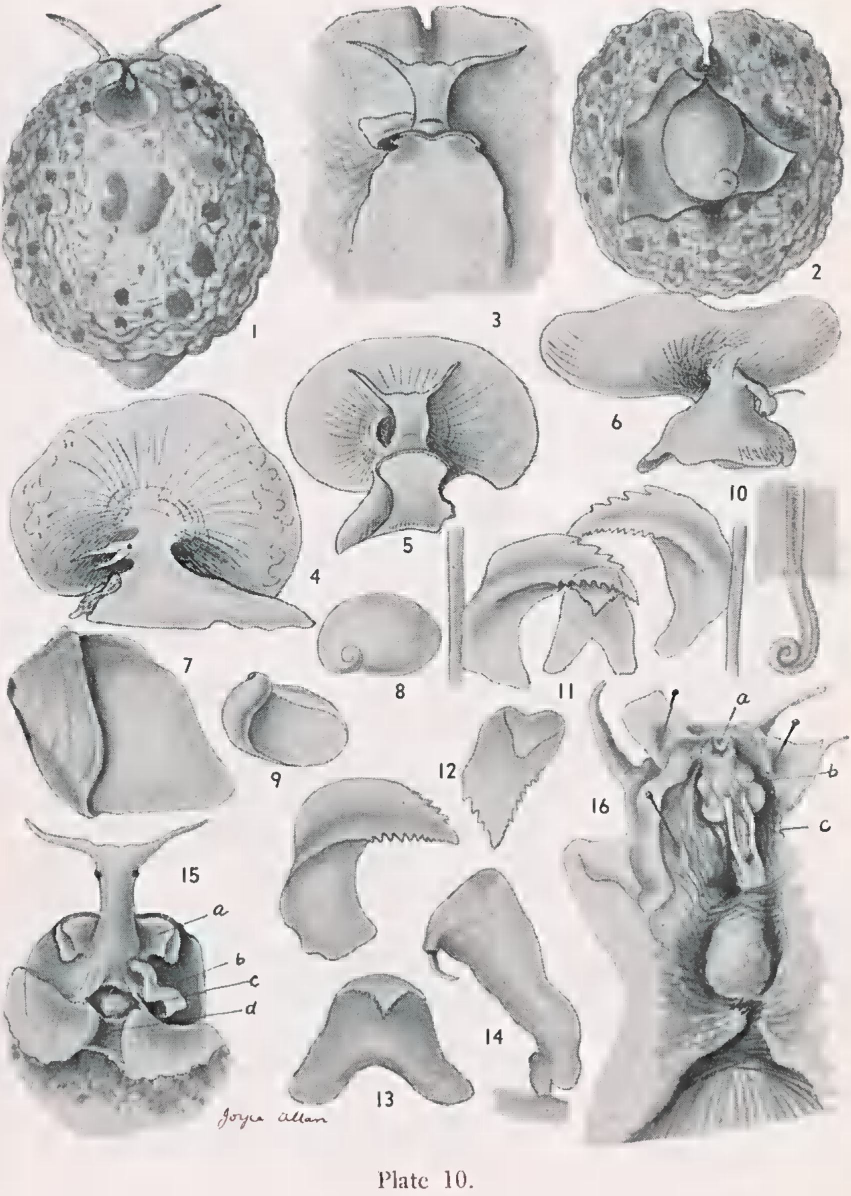
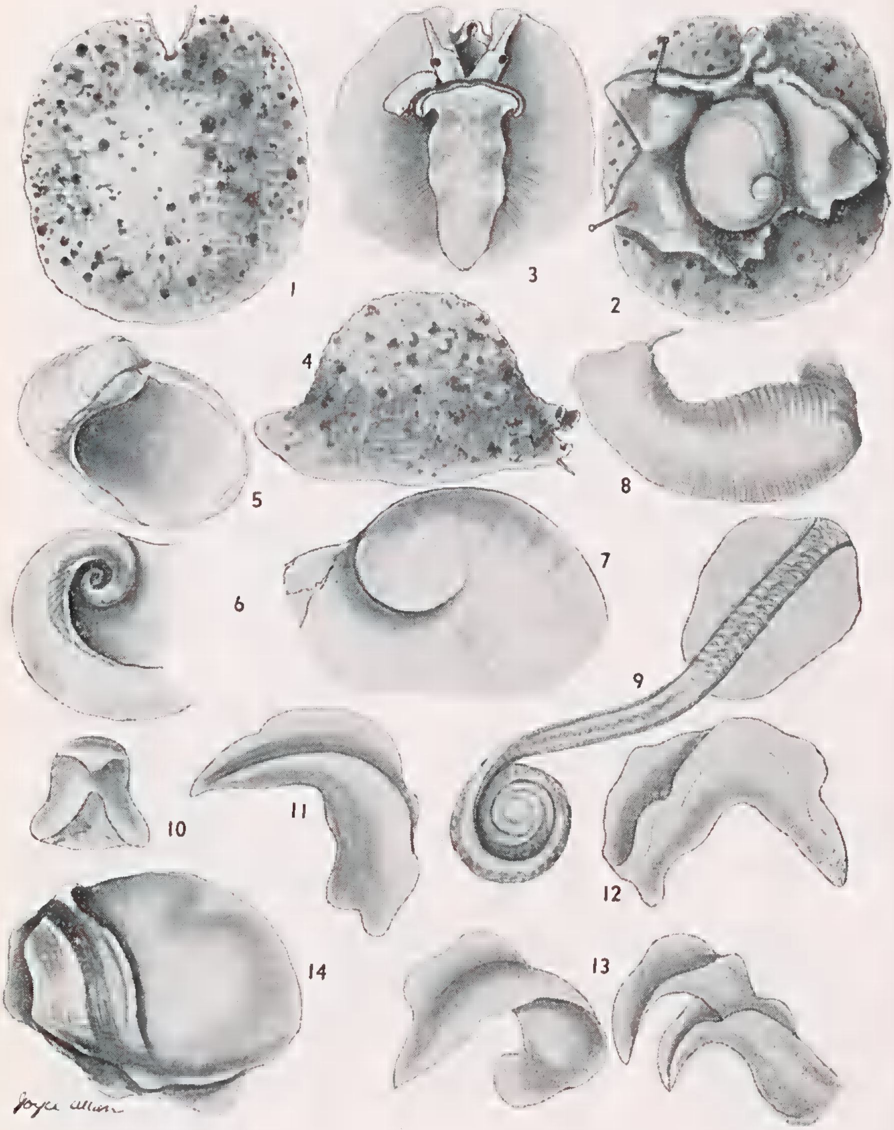


Plate 10.



(Plate II)

Plate 12.

TASMANIAN INTERTIDAL MOLLUSCA

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Text figures 1-2.

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Abstract.

Study of the Tasmanian mollusca reveals several aspects of species constitution, of affinity, and ecology, which seem to support the conclusions of other workers dealing with general ecology and with relationships. Thus the mollusca are part of an ecological unit, the basis of which is ecological rather than faunal, with affinities for areas of similar latitude probably discernible. The mollusca are also, in general, part of a southern Australian faunal entity extending to New South Wales and southern Western Australia, yet with individuality, and even a little Neozelanic affinity. Available evidence suggests, however, that the Tasmanian fauna is, for the most part, disinct from that of tropical Australia.

Introduction.

In this work the mollusca are studied as a separate entity of shore life, but without divorcing it from other shore life, as has been the approach of students of the Tasmanian mollusca in the past. This approach has been influenced, and materially aided, by the studies of general ecology carried out in recent years. Thus it has become evident (as has been long suspected) that some bio-geographical individuality exists in Tasmanian environments. This may even extend to the Victorian coast, where there are many faunal affinities, as well as some distinction. In reverse there are hints of the presence of South Australian and New South Wales influence. The relative position of the Victorian exposed coast fauna has been made clear by Bennett and Pope (1953), who are inclined to include this area with Tasmania in a cool, temperate "Region." Guiler (1954*b*) is in general agreement with this postulation. Guiler (1950) reviewed most of the literature having a bearing on the ecology, to which reference will be made herein. Accordingly, only a few remarks will be made relating to certain literature having a specific bearing on the present subject.

W. L. May studied the Tasmanian mollusca over many years, and his work is summarised in his "Index" (1923). Iredale and May (1916) proposed to designate the east coast of Tasmania the Maugean Region, and Bennett and Pope appear to favour the extension of this term to cover all of Tasmania and the exposed Victorian coast as above indicated. The north coast of Tasmania, according to Iredale and May, is pure Adelaidean (since renamed "Flindersian" by B. C. Cotton). Some agreement with this idea is possible, but an overall study inclines one to the view that the fauna is Tasmanian. It is also (if one likes) part of a Bass Strait fauna, with affinities with its surroundings which are less marked to the east. Essentially the differences between North Coast faunas and those of other parts of Tasmania are due to ecological factors, such as differences of exposure, and so on. From a broader viewpoint, this was recognised by Bennet and Pope (1953), but that there is a Flindersian influence was

* West Tamar, Tasmania.

recognised by Hedley (1904). Hedley's basic idea has been partly confused because some of his evidence was ecological, and because nomenclatorial revision has altered other aspects. He does not seem to have envisaged the full extent of the probable Bass Strait land area, but to have realised all its vicissitudes would have been a remarkable achievement even for an author of his calibre. Without going into details, it may be considered that the land bridge did actually exist. There has always been the danger of calling into existence such a factor to account for a fauna which is itself then used as proof of that factor. In this case geological evidence is gradually forthcoming to support the hypothesis. Assuming the land bridge, Hedley's division of the fauna must have occurred, but because of migrations of the fauna and the length of time since the land vanished, intermingling has occurred and a balance achieved. Iredale, Laseron and others have shown that some factor (i.e., migration) has been in force in the past to bring Tasmanian faunal influences off the New South Wales coast and the reverse in regard to the Tasmanian coast. Smith and Iredale (1924) found evidence of a probable Pleistocene strandline on the continental shelf off the coast of New South Wales. Associated was a fauna directly comparable with modern Tasmanian molluscs.

The eastern fauna did actually come into the Bass Strait area, but it is less obvious. The influx of the sea on to the Bass Strait land surface probably may be definitely regarded as being principally of western waters at first, and it is not surprising to find some western influences on north-eastern Tasmanian shores. If a western migration into Bass Strait was the initial one, it is natural to assume that its influence would in the end predominate. But it must be realised that this fauna (i.e., that now found in Bass Strait with some modification) may simply have been returning to a formerly held "home." No doubt, by the process of adaptation formerly outside forms came here and were able to survive. In addition, the fauna has now tended to assume a character of its own. Probably we may summarise the present position by asserting that the obvious Tasmanian elements tend to be found in the most exposed areas, while northern elements seek more shelter. Something further will be said of this later. This type of occurrence is commonly found elsewhere; for example, Peronian elements appear in Victorian bay faunas. The greatest influence in the long run on the shore fauna must be an ecological one, for the effect of change on metabolism is apt to be profound, and it seems a long recognised factor that it is easier for a shore animal to migrate north rather than south.

Another vexed question is that of the traces of New Zealand elements in the Tasmanian mollusca fauna. No evidence of direct communication between the two countries is forthcoming. There is the possibility that ocean currents were or are responsible. Or that a northward migration during a Pleistocene "shallow sea" met and mingled with a New Zealand migration in part, subsequently returning south to new shores. These possibilities are far from satisfactory, and do not take into account the land and freshwater faunal resemblances, although these could have branched from a "southern origin." No single factor will explain the difficulties of such affinities, and any evidence is certainly clouded by past migrations and present ecology.

The immediate problem then is the full interpretation of the ecology of the shore faunas. Thus students of the mollusca not taking all the evidence into account are apt to be led astray. Ashby (1926) proposed to alter Hedley's zoo-geographical regions on the basis of his chiton studies which were not sufficient alone, but he did realise individuality in the Tasmanian fauna.

The present work does not pretend to provide answers to the many problems involved, but is merely a study of the Tasmanian intertidal mollusca found on the various types of shoreline, together with some of the affinities with other parts of the Australian coast. The work is based on notes made during tours of the southern, eastern, northern, and western coasts, from the Derwent River Estuary to Marawah. The writer has also had the benefit of studying mollusca collected by Dr. Eric Guiler in southern Tasmania and from Trial Harbour on the west coast. Other references, duly acknowledged, are drawn from the literature. The writer is grateful to Dr. Guiler for his continued interest in the writer's work.

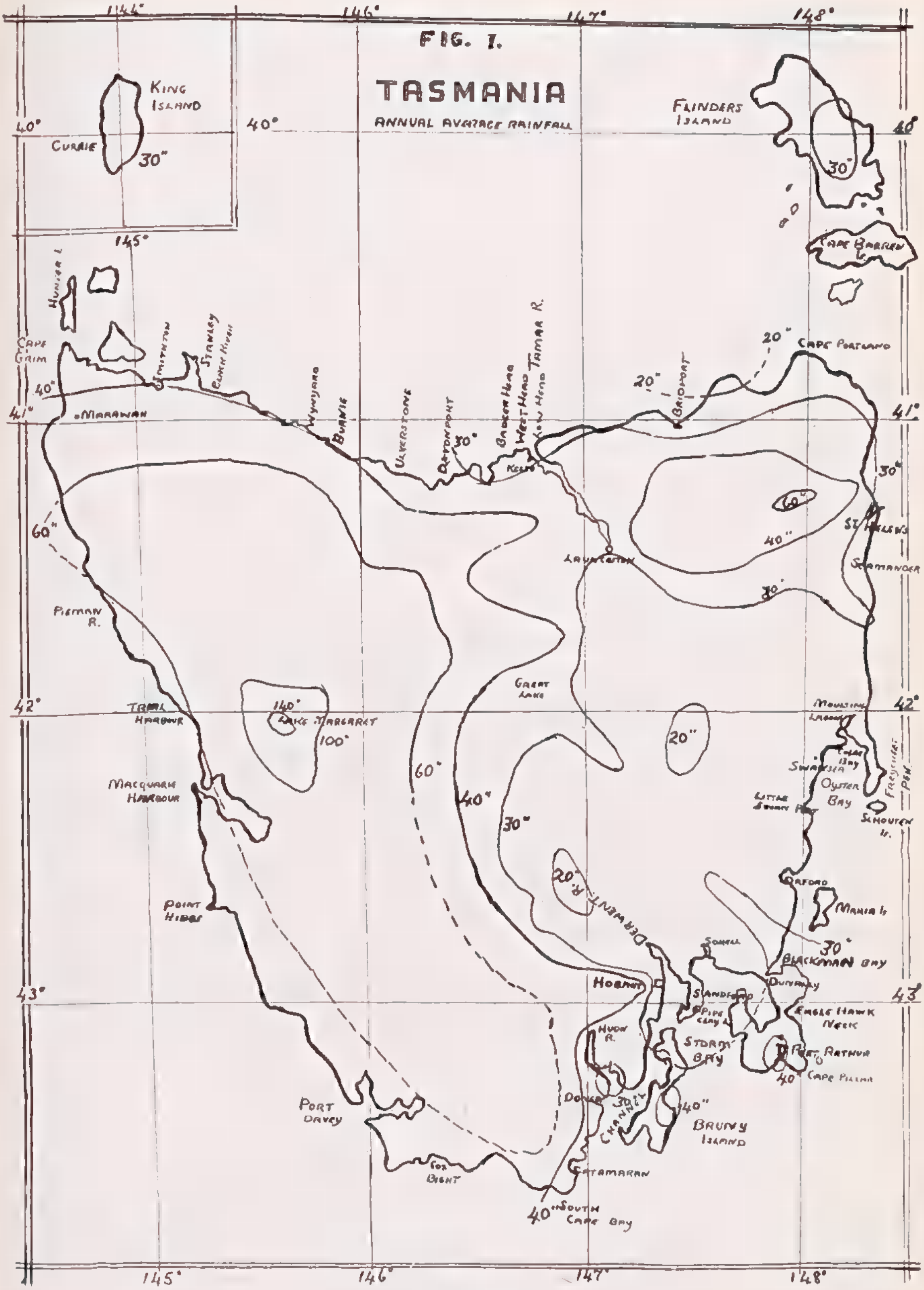
THE ENVIRONMENT

Tides.

Guiler (1950) described the greatest rise of tide in the Derwent Estuary (south Tasmania) as of the order of three feet six inches and the greatest fall of the order of five feet. On the north coast the maximum tidal range is of the order of nine to ten feet. The east coast and the west coast of Tasmania are comparable with the southern coast in the matter of tidal range. The essential difference lies in the fact of wave exposure on the oceanic coasts, where wave action and spray may extend the "intertidal" habitat very much beyond a presumed normal on which nomenclature is based.

Geology.

The general geology of Tasmania has been described by Nye and Blake (1938), who make general references to the coastline. The following remarks are based largely on the writer's own observations, substantiated by numerous references to the available literature. Much of the rocky shoreline of Tasmania consists of the highly resistant dolerite. In some places, principally in the north, more recent extrusive lavas are present. Ancient resistant metamorphosed sediments form headlands in certain places, while massive granites appear in others. Thus a great deal of the rocky shore is highly resistant to wave action and the environment is apt to be jagged and boulder strewn, with little in the nature of platform surfaces. In certain areas Peruvian mudstones and fillites outcrop on the shore, and in such places erosion has been more extensive, with the formation of platforms, caves and blowholes. Bays are frequently cut in soft Triassic sandstones, and there are stretches of emergent coast with sandy beaches backed by dunes, behind which lagoons are impounded—notably on the East coast. Flandrian drowning has contributed to the formation of estuaries, while emergence has provided mud flat and salt marsh in certain bays and lagoons.



Text figure 1:

Locality map and Isohyets.

Climate.

On the basis of Thornthwaite's system (Gentilli 1948), the climate of Tasmania may be summarised as follows. There is a sub-humid warm climate in the north, east, and midlands. There is a sub-humid cool climate in the south-east and central eastern midlands. There is a super-humid cool climate in the west, with a small area of cold climate on the Central Plateau. A map (Text fig. 1) has been prepared from information provided by the Weather Bureau, Hobart, showing the isohyets of rainfall which relate particularly to coastal climate. Certain inland centres of high and low rainfall are also included to make the above summary clear. The western high rainfall materially affects estuaries, and even bay waters in that area, by reason of the volume of water in the rivers. This is not true on the east coast, but a large volume of fresh water may enter bays and estuaries during winter floods. The headwaters of the Derwent and Tamar are in high rainfall areas, but the length of these rivers modifies the effect on estuaries.

The extent of dessication due to exposure to the heat of the sun is greater in the east and north where there are more cloudless days than on the west coast. Tasmania is in the path of the Westerlies, with occasional Antarctic influences. Hence greater turbulence may be expected on western shores, but all exposed coasts except those in Bass Strait are subject to oceanic conditions with gale force winds. Nevertheless, storms of western or eastern origin may concentrate in Bass Strait and produce gales with considerable wave action, and this is a common winter occurrence. The centres of the principal low pressure systems appear to pass just to the south of Tasmania during the winter. Other systems may develop in the Bass Strait region or to the east, while occasional tropical systems reach far enough south to influence the north and east. Other factors involved include the topography of the island and the ocean currents. Thus the warm East Australian current no doubt assists other factors in producing a considerably milder climate in the north-east of the State. There is apparently some westerly drift into Bass Strait, which will ensure western influences along the north. But the eastern influences are very strong, and Dannevig (1915) envisaged a building up of the waters in central areas. Bennett and Pope (1953) found that there is some westerly predominence.

Table 1 shows the maximum, minimum and average mean temperatures, and the highest and lowest recorded temperatures for certain coastal stations in Tasmania.

Table 1—Temperatures at Coastal Stations.

	Temperatures in degrees fahrenheit.				
Locality	Maximum mean	Minimum mean	Highest recorded	Lowest recorded	Average mean
Burnie	59	38	85	30	48
Cape Bruni	57.9	47.3	99	28	52.6
Cape Sorell	58.7	49.2	90	30	53.9
Currie	61.1	49.8	96	30	55.4
Eddystone Point	61.7	49.6	96	30	55.7
Hobart	61.9	46.8	—	—	54.3
Hythe	59.8	44.1	—	—	41.9†

Kettering	59.3	42	—	—	50.6
Low Head	60.1	49.1	84.6	27	54.6
Maatsuyker Is.	56.7	47.1	94	31	51.9
Marawah*	58.4	46.1	—	—	52.3
St. Helens	63.9	44.4	103	20	54.1
Stanley	60.2	48.5	93	20	54.3
Swansea	63.2	45.6	104.1	24	54.4
Zeehan	59.1	43.5	99.2	19.4	51.3

† The low average mean record for Hythe probably is an error.

* Marawah is some miles inland from the West Coast.

Table 1 is based on figures kindly provided by the Weather Bureau at Hobart. Certain sea temperature records are given by Guiler (1950) and Kershaw (1957), while Bennett and Pope (1953) give a table of temperatures from readings by H.D.M.S. "Galathea" in "South-eastern Australian waters." The variability of rainfall in Tasmania is discussed by Scott (1956), who remarks the greater variability in the east which is significant in the final analysis of differences between east and west, and in the conditions experienced in the east and north-east.

Intertidal Classification.

There has been some controversy on the matter of classification of various parts of the shore. Hence the Tasmanian work of Guiler (1950, 1953) is followed for two reasons—firstly for the sake of uniformity, and secondly because the writer has found it in general sound in application. The zones recognised by Guiler are "the Supralittoral," "the Midlittoral" and "the Infralittoral." The Supralittoral and the Midlittoral are separated by a "Supralittoral Fringe," the highest area reached by spring tides. The Midlittoral zone is the normal tidal area. The Midlittoral and the Infralittoral are separated by the "Infralittoral Fringe," which is the region exposed only at extreme low spring tides. The flora and fauna of these areas have sufficiently distinctive features to enable their being recognised in the field. Guiler has recommended that for further subdivision of these zones, the term "Belts" be used, each belt to be distinguished by its characteristic plant or animal, in general the dominent species of that belt, or part of the shore. These "parts" of the shore are well recognised, but different terms have sometimes been used in defining them. The writer has no intention of discussing the matter and hereinafter the above scheme will be used. The nomenclature is also here applied to sandy shores as far as possible in order to avoid terms such as "midtide" which convey little without detailed knowledge of a particular shoreline.

A different mode of classification has been used by Guiler (1951) for a lagoon, based on the presence of a belt of the sea-grass *Zostera*. Thus there are three zones, the "Supra-*Zostera*," the "*Zostera*," and the "Infra-*Zostera*." These are subdivided into "Belts." This has come in for some criticism, but the writer has found it useful in sheltered waters in northern Tasmanian localities, and it is here used where desirable. It is possible to correlate this scheme with rocky shore zones in some places.

Intertidal Belts.

1. *The Supralittoral and the Supralittoral Fringe.*

As pointed out by Guiler (1953) and Cribb (1954) a belt of yellow, orange and grey lichens is often conspicuous on Tasmanian coasts, notably where there is considerable spray. In the writer's opinion, this is as true of the north coast as the above authors found it true of southern and eastern coasts. The first molluscs to be encountered on the exposed shore are found immediately below this belt, in the Infralittoral Fringe. *Melaraphe unifasciata* (Gray) and *Melaraphe praetermissa* (May) here form a belt which is only absent when *M. unifasciata* cannot obtain a hold or the habitat is virtually absent. On the sandy ocean shore there is no equivalent mollusc, but in sheltered areas *Ophicardelus ornatus* (Ferussac) and *Bembicium auratum* (Quoy and Gainmard) (*qv.* Cotton 1956 *b.*) may be present on rocky shores, and *Salinator solida* (Von Martens) on mud flats. *Ophicardelus* is only present in certain very sheltered localities. *Bembicium* commonly replaces *Melaraphe* as a belt forming species in sheltered areas, but is probably not found so high on the shore as the Infralittoral Fringe, and therefore is not strictly equivalent to *Melaraphe*. On the exposed shore *Bembicium nanum* (Lamarck) occurs throughout the Midlittoral where conditions are suitable, and does not compete with *Melaraphe*. *Melaraphe unifasciata* may occur on sheltered shores, but frequently is small and few in number of individuals. *M. praetermissa* appears to favour more moisture in the form of increased spray or tiny pools in which the writer has observed it to congregate. This latter species extends to Victoria, whereas *M. unifasciata* is present as far north as southern Queensland, (Endean, Kenny and Stephenson 1956).

2. *The Midlittoral.*

On the North Coast a *Melanerita* Belt is referred to by Kershaw (1957), in which *Melanerita melanotragus* (Smith) is in noticeable numbers associated with *Bembicium nanum* (Lamarck), *Austrocochlea constricta* (Lamarck) and *A. concamerata* (Wood), these latter species usually seeking shelter. *Melanerita* is only present on coasts with some degree of exposure; it is only common on the North Coast, but is present on the East Coast and the West Coast at least as far south as Trial Harbour. The northern occurence is more nearly equivalent to that of the mainland of Australia than other parts of Tasmania. On sheltered shores *Bembicium auratum* is the dominent species of this area, although on certain partly exposed shores in the bays or estuaries such as north of Kelso in the Tamar Estuary it is reduced to an associate of *Austrocochlea obtusa* (Dillwyn) in its smaller estuarine form.

The Barnacle Belt is next present on most rocky shores, though sometimes reduced by competition with mussels. Juvenile *Melaraphe* may be found in this area. *Bembicium*, *Austrocochlea spp.* and *Melanerita* are found over most of the shore. The barnacles may be succeeded or, as inferred above, almost replaced by Mussel Belts, as at Bridport, where *Modiolus pulex* (Lamarck) competes very strongly with the barnacles, or again, preceded as is often the case on the East Coast by *Austromytilus rostratus* (Dunker) (*olim Brachyodontes*, Laseron 1956). In the sheltered West Arm of the Tamar River the competition is reduced, as *Modiolus*

pulex tends to prefer rough surfaces, while the barnacles, *Elminius modestus* (Darwin), occupy smooth surfaces, but in any case the sheets are not continuous, probably due in part to influxes of muddy sand, or mud.

On the exposed Tasmanian coasts there is commonly present a Patelloid Belt occupied principally by *Cellana solida* (Blainville) and *Siphonaria app.* with other limpets. This belt is present at West Head on the North Coast, but the ocean coast belt is the more populous. *Cellana solida* occurs on semi-exposed coasts such as Oyster Bay and even in relatively sheltered bays such as Coles Bay at the head of Oyster Bay (East Coast), but not on sheltered estuarine shores. The sheltered shore has no Patelloid Belt as such, but the equivalent area tends to be dominated by *Siphonaria diemenensis* Quoy and Gaimard, but there are associates such as *Bembicium* and sometimes the pulmonate slug, *Onchidella patelloides* (Quoy and Gaimard), a species found in considerable numbers in the West Arm, Tamar River, but not apparently in the south. On other coasts, semi-sheltered but not estuarine, particularly in the south, *Mytilus planulatus* Lamarck forms an important belt, much as used to be observable at the head of Port Phillip Bay in Victoria.

On most types of coast there is present a *Galeolaria* Belt consisting of the tubes of the serpulid worm *Galeolaria caespitosa* Lamarck, which encrusts the rocks. The encrustation is sometimes as a thin veneer, as on the most exposed parts of West Head studied by the writer, or reaching a thickness of three or four inches or more in favoured sheltered places. *Galeolaria,* however, does not form a belt or is entirely absent in fully exposed localities in Tasmania, unlike New South Wales where it apparently favours surf. Guiler (1954) has drawn attention to this point. Hence this belt is only of significance as a shelter for molluscs on coasts having various degrees of shelter. Both Guiler (*loc. cit.*) and the writer have noticed that *Galeolaria* appears to have periods of heavy mortality, when whole clumps break off and the population is reduced to an insignificant unit from which slow recuperation follows. It is probable that the sheltering population of molluscs, worms, etc., also suffer as a result. These include *Montfortula spp.*, juvenile *Sypharochiton maugeanus* Iredale and May, *Kellia australis* (Lamarck), *Lepsithais vinosa* (Lamarck) (preying on the others), and sometimes *Onchidella patelloides* amongst many others. In this area with increase of exposure the limpet, *Patelloida alticostata* (Angas) is important, and if often encrusted with the tubes.

In the vicinity of *Galeolaria* there may be a belt of the necklace weed *Hormosira banksii* (Turn.) Decaisne which provides shelter for many gastropods including the limpet *Chiazacmea flammea* (Quoy and Gaimard) in one of its forms. *Bembicium, Austrocochlea* (*Fractamilla*) *concamerata* (Wood), A. (*Chlorodiloma*) *adelaidae* (Philippi) and lower down A. (C.) *odontis* (Wood) are the common species, and these may have associated the sea star, *Patiriella exigua* (Lamarck), etc. On the North Coast shores *Modiolus pulex* is often reduced to a modified belt of small individuals, closely packed over small areas with barnacles, *Chamaesipho columna* (Spengler) and *Tetraclita purpurascens* (Wood) in association.

The lowest Belt of the Midlittoral is that occupied by Coralline algae, which often form a turf on exposed shores. The mollusc population rapidly increases in variety and numbers, and many appear under stones,

including chitons, particularly *Ischnochiton elongatus* (Blainville) and *Ischnoradsia evanida* (Sowerby), with *Poneroplax albida* (Blainville) or *P. costata* (Blainville) according to the degree of exposure. In Southern areas the New Zealand *Amaurochiton glaucus* (Gray) is slowly spreading, and is noticeable in many places. Common molluscs are *Austrocochlea, Cominella, Dicathais, Pleuroploca, Micrastraea aurea* (Jonas), *Notohaliotis ruber* (Leach), *Forelepas tasmaniae* (Sowerby), *Patellanax, Notoacmea* (higher on sheltered shores), *Subninella undulata* (Solander), and many others. The species have been omitted in several cases as some vary with exposure, which will be clear later in this work.

Adjacent to the rocky shore of the West Arm, but not on the soft muds or sands unless there is rock surface just underneath, a great deal of Midlittoral is occupied by *Velacumantus australis* (Quoy and Gaimard), (Family Cerithidae). This mollusc is also present in such sheltered places as Port Arthur (Cribb, 1954) and Pipe Clay Lagoon (Guiler, 1951 *a.*), but the writer has not seen anything equivalent to the development in the West Arm. The species is not present as high as the *Bembicium* Belt usually, and is also only a minor constituent of more exposed faunas. It is not present on exposed coasts. It is usually absent except in exceptional conditions on parts of the shore where a *Zostera* habitat is present.

The *Zostera* Belt appears to extend from a point in the Barnacle Belt to a point in the *Galeolaria* Belt apparently central. The upper limit appears to vary with local conditions, and the writer has noticed it almost reaching the *Bembicium* Belt. The associated fauna is largely bivalves but with certain important gastropods. Stones lying on the shore or adjacent rock surfaces have in some areas enabled some correlation to be made between belts on the *Zostera* type of shore and rocky shore belts, but these are not accurate, hence the ill-defined extent of the *Zostera* Belt proper, indicated above. There are two types of shore upon which *Zostera* may appear. These are the sandy or muddy-sandy lagoon (e.g., Pipe Clay Lagoon) or estuarine inlet (e.g., West Arm, Tamar River) enjoying maximum shelter, and the sheltered bay or sandy estuarine shore. The best example of the latter type with which the author is familiar is the sandy shore north of Kelso, and Kelso Bay a little south of Kelso, both localities being in the Tamar River and hence estaurine. The West Arm, Kelso Bay, and the sandy shore north of Kelso have increased exposure in each case, but many molluscs are common to each. The first essential difference lies in the numbers of individuals of certain species, and secondly some species which occur outside the river mouth find a place north of Kelso, but not in West Arm, while some are peculiar to West Arm and/or Kelso Bay, but do not reach the river mouth. Other shores where *Zostera* is of note spring to mind, but these serve as examples, while in D'Entrecastreau Channel *Zostera* passes below low tide and is of interest in relation to the proximity of the Scallop beds, but is outside the scope of this work.

In other parts of Australia a Zosteretum is formed by this plant, in which populations of molluscs and other animals find shelter. This is hardly the case in Tasmania, but the writer has found small areas sheltering numbers of animals which perhaps may be referred to as a modified form of Zosteretum.

As already noted, the Supralittoral Fringe on the mud flat is commonly occupied by *Salinator solida* (Von Martens) and this species will even occur where there is a fair admixture of sand, as on the sheltered shore below the township of Stanley, north Tasmania. But it appears absent on the sandy shore north of Kelso. If there are stones present, the Midlittoral may be commenced by *Bembicium* and *Austrocochlea* as at Kelso, or *Bembicium* and *Ophicardelus* as in parts of the West Arm, the latter shells being in the Supralittoral, or S.-L. Fringe, otherwise sand or mud dwellers are encountered.

Provided there is sufficiently firm substratum, *Bembicium* will find a place and may form a Belt. It has done so in Pipe Clay Lagoon (Guiler 1951) and this will be used as a starting point. The following Belt is that formed by *Eubittium lawleyanum* (Crosse), which is very extensive in Pipe Clay Lagoon, much reduced at Kelso and other parts of the Tamar, although the number of individuals to the square foot is much the same. The Belt in the West Arm is much reduced where it occurs. The substratum here is muddier and the shore steeper, so that the amount of the shore exposed is a function of the tidal range and not the shallow depth as at Pipe Clay.

Assiminea brazieri (Tenison-Woods) is a localized dominant in the areas under discussion and does not form a belt. The next Belt then is that formed by *Anapella pinguis* (Crosse and Fischer) in Pipe Clay Lagoon. In the West Arm this Belt is very narrow and often absent. It is succeeded by pockets of *Katelysia peroni* (Lamarck) in West Arm, this species being virtually as plentiful as *Anapella*. *Katelysia spp.* are recorded from Pipe Clay Lagoon by Guiler (*loc. cit.*) under the name "*Marcia.*" *Anapella pinguis* is more plentiful in Kelso Bay, but both this species and *Katelysia peroni* may only be described as present at Kelso-north. Here as in Pipe Clay *Katelysia scalarina* (Lamarck) is relatively common at this point.

Zostera nana now forms a Belt which is also the *Zostera* Zone of Guiler's Lagoon classification. In Pipe Clay the compact beds do not favour the burrowing bivalves, and this is true of the West Arm, but not so of the Kelso localities. *Macoma deltoidalis* (Lamarck) and *Katelysia scalarina* (Lamarck) are both found burrowing in the beds, while in firm sand where *Zostera* is sparse at Kelso-north, *Austromytilus erosus* (Lamarck) is found anchored in the substratum by the byssus to firm objects. Guiler records *Austromytilus rostratus* (Dunker) from the *Zostera* of Pipe Clay, and he has found this species at Trial Harbour on the West Coast, and *A. erosus* in a sheltered area at Fisher Island at the same locality.

In the Tamar localities the dominent animal of the *Zostera* or part thereof is *Salinator fragilis* (Lamarck), but is only among those present in Pipe Clay. In West Arm it is plentiful throughout the *Zostera* and often in other places. In Kelso Bay *Austrocochlea obtusa* is co-dominant, while at Kelso-north *Salinator fragilis* is only dominent on the shoreward edge of the *Zostera* belt. Over the remainder of the Belt there is a varied population, including *Austrocochlea obtusa* and *A. constricta, Cominella lineolata* and *C. acutinodosa, Parcanassa pauperata* (Lamarck), *Assiminea brazieri,* and *Cacozeliana granarium* (Kiener). The crab *Paragrapsus quadridentatus* (Milne Edwards) is also present. In the West Arm there is *Paragrapsus grimardii* (Milne Edwards) and *Mictyris platycheles* Milne Edwards, as at Pipe Clay Lagoon.

In the Infra-*Zostera* Zone, *Katelysia corrugata* is recorded by Guiler as the first dominant for Pipe Clay. This species is not present in the northern localities, but *Katelysia scalarina* is present at this point, though not in numbers. At Kelso-north it is a much more robust shell than in other areas, and resembles more nearly the type of shell found on the mainland. At Kelso-north *Cacozeliana granarium* became very numerous on the edge of the *Zostera* bed, but close inspection revealed that many shells were dead.

Austrocochlea obtusa (Dillwyn) is then dominent in Pipe Clay to the Lagoon bottom. In West Arm this species is present at a similar level, as also at Kelso. In Kelso Bay it is uniform throughout the shore, while at Kelso-north it appears best developed in the *Zostera* Belt. In these estuarine waters there are two forms, the smaller of which is generally found on the higher parts of the shore. In West Arm a large, robust form lives at extreme low tide and only occasionally reaches higher parts of the shore and is never in numbers. In East Coast bays this robust form may be the only one present, and is larger still. A small form is present in Pipe Clay Lagoon.

In Kelso Bay the bivalve *Laternula creccina* (Reeve) may appear at extreme low tide, while in West Arm it is replaced by *Laternula tasmanica* (Reeve) and this is equivalent to *Laternula recta* (Reeve) of the Mainland.

The Sandy Beach.

The number of molluscs actually living on the sandy beach is small, and many are only "exposed" at extreme low tide, but are frequently washed in shore alive by heavy seas. The first species which become obvious live in the Midlittoral, in an area approximately equivalent to the Zostera Zone of more sheltered shores. In point of fact, one of these species, *Uber conicum*, is found alive on the *Zostera*, as for example at Kelso-north. Universal on sandy shores, and probably in general, dominent is the bivalve *Amphidesma augusta* (Reeve), so far as the north and east are concerned, but in Sandy Bay, and in the vicinity of Dunally in the south, *Amphidesma erycinaea* (Lamarck) appears to replace it so far as is known to the writer. Cotton and Godfrey (1938) observe that Flindersian examples are smaller than Peronian, and this applies in Tasmania, in that North Coast examples are smaller than those from East Coast localities. *Uber conicum* (Lamarck) is found in a similar position on most sandy shores examined by the writer, exposed and semi-exposed, but did not appear on the most exposed beach on the East Coast visited, a place near Scamander, but as a heavy sea was running accurate observations were difficult.

Living rather lower and apparently universal is the Venerid bivalve, *Placamen placidum* (Philippi). All localities visited on the north, east and south yielded examples alive. However, none were obtained at Marawah on the West Coast, but here again results were hampered by heavy seas, and few bivalves were obtained. *Katelysia scalarina* is generally found, and at Sandy Bay near Hobart is a robust shell associated with *K. corrugata*. In the north *K. peroni* appears, but does not appear to favour much exposure, and is essentially an estuarine shell. *Anapella pinguis* is common and especially plentiful in East Coast sheltered lagoons. *Notospisula trigonella* may also be observed. Other bivalves live in the Infralittoral

Fringe or below, and will be tabulated later, but some may now be mentioned. Very common on the East Coast is *Glycymeris* (*striatularis*) *suspectus* Iredale. This shell is rarely found alive and is not strictly intertidal, but is referred to here as it is especially characteristic of the East Coast. Similarly, *Tawera gallinula* (Lamarck) is very common on the East Coast, but is also found on most other beaches. *Flavomala biradiata* (Wood) is best developed with some shelter, though it is found on the exposed shores of the North Coast also. However, this species does not appear to reach beyond semi-exposed Eastern shores, such as Oyster Bay. *Electroma georgiana* (Quoy and Gaimard) is commonly found attached to weed or stones of the Infralittoral Fringe adjacent to sandy shores. An important gastropod of the North and East which should be mentioned is the well-known *Phasianella australis* (Gmelin).

3. *The Infralittoral Fringe.*

For convenience some remarks have already been made concerning this part of the sandy shore; it is now proposed to return to the rocky shore. In this area Ascidians may form a belt, while the bulk of the algal flora begins here, and provides the most notable cover for molluscs. Many also find shelter beneath stones. The fauna of this area cannot be dealt with exhaustively in this work, and only a few of the more obvious will be mentioned here. Numerous shells have been collected and are still being sorted and studied.

An important shell is *Notohaliotis ruber* (Leach), which May (1923) records from "East and South." However, it is present at West Head and elsewhere in the North. *Sabia conica* (Schumacher) is frequently found attached to this and other shells, also in semi-sheltered areas. *Mesoclanculus plebejus* (Philippi) is often found under the same stones as *Notohaliotis*, while *Macroclanculus undatus* (Lamarck) and *Euriclanculus limbatus* (Quoy and Gaimard) are more common in the East than the North; *M. plebejus* is found everywhere. Also encountered on stones are *Rissoina fasciata* Adams, *Serpulorbis sipho* (Lamarck) (semi-sheltered), *Ellatrivia merces* (Iredale), *Marginella pygmaeoides* Singleton, *Floraconus anemone* (Lamarck), *F. peronianus* Iredale (East Coast), *Austrodrillia beraudiana* (Crosse) (also on the West Coast), *Zemitrella tayloriana* (Reeve), *Z. lincolnensis* (Reeve), *Z. vincta* (Tate), *Z. acuminata* (Menke) (North and West), *Syrnola aurantiaca* (Angas), *Eulima auger* Angas (both North). Most of these shells occur in both exposed and semi-exposed localities, but the full degree of exposure is not clear in all cases. A Bass Strait shell, *Galfridus eburneus* (Petterd) has been taken by Guiler at Point Puer in the South. *Dicathais textiliosa* (Lamarck) is widespread, particularly in the North and West, favouring exposure and often higher on the shore. The Peronian *Dicathais orbita* (Gmelin) occurs on the East Coast, and occasionally on the North Coast, but not often west of the Bridport-Tamar area. May used this species for his figure (1923, Pl. 11, fig. 15). *Ischnochiton elongatus* is commonly met. *Ischnoradsia evanida* (Sowerby) is very plentiful at exposed Northern localities. *Acanthochiton sueurii* (Blainville) occurs in sheltered places in West, North and South. Other gastropods are *Zella bedommei* (Petterd) (Coles Bay), *Fossarina petterdi* (Crosse), (South and Point Puer), and *Fossarina*

legrandi Petterd (West and South). Some of these shells live in the algae. Others better known from various algal species are *Thalotia conica* (Gray) (very common on the sheltered shore at Circular Head, also West Head, etc.), *Phasianotrochus irrisodontes* (Quoy and Gaimard), *P. eximius* (Perry) (also on the exposed Kelp weed), *Cantharidella tiberiana* (Crosse), and in Kelp roots *Scissurella ornata* May and *Scissurona rosea* (Hedley). These last two are rarely exposed, except by very low calm seas.

A number of gastropods occur on sandy shores in the Infralittoral Fringe region, some rather rarely. The most plentiful is *Bankivia fasciata* (Menke), which is washed to this position from weed. This shell is much larger on the East Coast than elsewhere. *Ectosinum zonale* (Quoy and Gaimard) is a true sand dweller, while others are *Marginella formicula* Lamarck, *M. tasmanica* Tenison-Woods, *Alocospira marginata* (Lamarck), *A. oblonga* (Sowerby), *Baryspira petterdi* (Tate), *Quibulla tenuissimma* (Sowerby), *Philine angasi* (Crosse and Fischer). Others are found alive but are accidental to this area.

It cannot be said that any of the shells of the Infralittoral Fringe have special significance except as part of the general ecology, for on rocky shores they are dependent on other dominants for shelter, though their own numbers may be considerable. Young *Ostrea angasi* may occupy this position in some numbers in sheltered waters. For example, this species is an important constituent of the edge of a mudstone platform in the West Arm, Tamar River. Sand dwellers of this area are more often below tide levels than above. As with the Olividae, they rarely approach the shore above tide level, being sand bar dwellers. The number and variety of species, though less than in northern States, are probably more significant than realised by comparison with other rocky shore dwellers, because the latter are so obvious and numerous. In this work, concern is more for the constituent individuals than for the zones and belts which serve their purpose as guides. It is, therefore, a pity that it is not possible yet to present a full census of them.

4. *The Patelloid Belt Fauna.*

Brief mention only has been made of the limpet and limpet-like molluscs, but fuller discussion is merited. *Cellana solida* is the characteristic limpet of the Patelloid Belt. It has been thought that the South Australian *Cellana rubraurantica* (Blainville) occurred in Tasmania, but Macpherson (1955) has shown that *C. rubraurantica* is a synonym of *C. solida*. Iredale (1924) assigned the name *C. solida* to the East Coast shell and expressed curiosity concerning the species on the North Coast. However, there is only one species of *Cellana* on all Tasmanian shores of sufficient exposure. *Cellana tramoserica* (Sowerby) occurs elsewhere, as discussed below. Confusion concerning *C. solida* probably first arose owing to the variability of the sculpture. Examination of numerous specimens shows that more shells with narrow ribs relatively closely spaced occur on the East Coast than on the North Coast, where broader ribs tend to predominate. On the East Coast, shells with narrowest ribs occur in sheltered places, such as Coles Bay. However, series from many localities indicate that variation is always present in some degree and has no specific

importance. True races cannot be recognised at present. Another confusing point is that young shells can be taken for a different species. Macpherson (*loc. cit.*) has pointed out that Blainville actually described *C. solida* from the young shell.

No form of *C. solida* has ribs so narrow as *C. tramoserica*, although in the case of stunted shells some doubt could arise at first sight. *Cellana tramoscerica* (Sowerby) is at the southern limit of its range on Tasmania's east coast, and, as May (1923) has observed, it is very much smaller. In appearance it is none the less typical (though only a minor constituent of the fauna), with only an occasional specimen seen on the North Coast and probably absent altogether on West and South. Its range in Tasmania may be put down as East and North-east. No large shell of this species has been seen in Tasmania, and all large eroded *Cellana* may be identified in the field without hesitation as *C. solida* (Blainville).

Very little has yet been published concerning the West Coast limpets. So far as has been observed, the essential difference between this coast and the East Coast lies in the number of individuals rather than species, so that it is thought that the Patelloid Belt is much more marked on the West Coast. The writer has seen the limpets collected by Guiler on the West Coast at Trial Harbour, but information as to their distribution has not yet been published. Near Marawah, the writer was unable to collect many live shells due to rough seas, although a large series of dead specimens was collected for comparison. At Trial Harbour, Dr. Guiler found *Cellana solida, Patellanax peroni* (including the form *P. squamifera*), *Patelloida victoriana, Patellanax chapmani, Patelloida latistrigata,* and at Fisher Island *Patelloida alticostata* and *Patellanax chapmani.* In the South, Dr. Guiler has taken *Patelloida latistrigata, Patelloida alticostata, Cellana solida,* and *Patellanax peroni.* Other species would be difficult to reach owing to the constantly surging seas. All the species mentioned above have been collected by the writer on the East Coast. On the North Coast he has collected *Cellana solida, Patelloida alticostata, Patellanax chapmani, Patelloida latistrigata,* but not *Patellanax peroni.* However, two dead specimens were taken on the west side of the Nut, Stanley.

Patellanax peroni has its habitat in the Infralittoral Fringe of the ocean rocky shores. *Patellanax chapmani,* on the other hand, occurs in areas with some degree of shelter, such as that already referred to as Kelso-north. There is some indication that *Patelloida alticostata* seeks some shelter in the West, being absent from exposed places. This may be true in the far South, but it is present in exposed places elsewhere. Dr. Guiler took it at Point Puer, although he does not refer to it when discussing Eagle Hawk Neck fauna. It should be noted that the names used are not necessarily the same as those used by Guiler, who in his earlier work followed May (1923). There appears to be some variation in the ornament of this species. *Patelloida victoriana* is especially common at Marawah on the West Coast, and may be much less important on the East Coast.

Limpets which Macpherson (*loc. cit.*) places in the family Acmaeidae (family Lotiidae in Kershaw 1955) have their habitat in the Midlittoral in sheltered areas, and in the Patelloid Belt the Infralittoral Fringe in exposed places. *Notoacmea petterdi* (Tenison-Woods) does occur at higher levels, however, and its range so far as is known to the writer is East Coast

(Bicheno), north (one specimen, West Head), North-east and West (Trial Harbour, Guiler). Macpherson (1955) indicates North-west Tasmania, although her map shows the distribution extending to a point south of Hobart. Its extension to Trial Harbour is particularly interesting, as its main distribution is Peronian.

Notoacmea scabrilirata (Angas) is found in most places which are sheltered or semi-sheltered. It is gregarious under stones, but individuals are found over most of the Midlittoral below the *Bembicium* Belt. It may be most common at lower levels, but in the West Arm at any rate, it cannot be said to be peculiar to any defined belt. In more exposed places, a limpet for which the writer uses the name *Conacmea subundulata* (Angas) is found most plentifully on bare surfaces just below the *Galeolaria* Belt. May (1923) says its habitat is estuaries and inlets, but the writer has not found it in such places in the north. Guiler, however, has found *Conacmea corrosa* Oliver in sheltered places where May also found it. *Conacmea subundulata* also appeared at Trial Harbour, and, in addition, *Notoacmaea mayi* (May). This latter species appears to have more exposure tolerance than the others. Dr. Guiler found it at Freycinet Peninsular where there is perhaps somewhat less exposure than at Trial Harbour (although one is not in a position to make comparisons), and also in the sheltered southern Barnes Bay. It seems likely that the species can withstand a fairly wide range of conditions. Also at Trial Harbour is found a small *Chiazacmea* species. At present this genus is best known in somewhat sheltered places in Tasmania by the species *Chiazacmea flammea* (Quoy and Gaimard), which seems absent from both oceanic and very sheltered coasts. In the north a variety, or subspecies, occurs at Kelso and at West Head, as well as elsewhere, for which one has continued to use the name *Chiazacmea mixta* (Reeve), although this matter may need further investigation. At Kelso-north in the estuary it lives at a low level, apparently rarely above the Infralittoral Fringe, but while it also lives in that position at West Head, it has appeared in the shelter of *Hormosira banksii* in small pools at the highest parts of the Patelloid Belt. Another subspecies, *Chiazacmea mimula* (Iredale), has been recorded from Blackman's Bay, but the writer has not seen a specimen.

The next group of the Patelloid Belt consists of species of the family Siphonariidae. From an ecological point of view it is probably best to use the generic name "*Siphonaria*" for these, as the taxonomy has been somewhat confused. Australian workers (Iredale 1940, McAlpine 1952) introduced new generic names subdividing the group, but Hubendick (1946, 1955) states that these (i.e., those with which we are here concerned) can only represent sections of the "subgenus" *Siphonaria*. The writer, however, has used these so-called genera as sub-genera of *Siphonaria*, and this would not have mattered seriously but that one of these, *Ductosiphonaria*, has to be abandoned (Hubendick 1955). Moreover, the species belonging to *Talisiphon* Iredale are regarded by Hubendick (1946) as belonging to *Pachysiphonaria* Hubendick, to which he also allots *Siphonaria funiculata* Reeve and several South American species. On this basis, *S. tasmanica* and *S. funiculata* would be placed in the subgenus *Pachysiphonaria*, but this obviously has zoogeographical repercussions. These cannot be discussed here, but merely borne in mind. Finally, Hubendick

contends that *Hudendicula* McAlpine, as already inferred above, is but a section of subgenus *Siphonaria*. Consequently *Pachysiphonaria* and *Hubendicula* cannot consistently be used on the same basis. All the Tasmanian shells would thus need to be placed in the genus *Siphonaria* if the confusion of complicated nomenclature is to avoided. The alternative is to abandon the Australian names in favour entirely of those of Hubendick. To do this would be to imply criticism of this use of these names for other Australian species, which the writer is not prepared to do, nor has he sufficient information on the Tasmanian shells to enable acceptance of Hubendick's nomenclature at present, although no criticism is here intended or implied.

Thus to aid in uniformity in Australia the writer favours, and proposes to use the genus *Siphonaria* in ecological work. The species *Siphonaria diemenensis* Quoy and Gaimard is universal in Tasmania, and there are several forms. Thus *S. dimenensis* lives on rock platforms, or large aggregations of shingle in both exposed and sheltered places. Where there are individual stones, isolated heaps, or other structures breaking up the continuity of the habitat, a form occurs closely resembling that figured as "var. *scabra*" from Port Jackson by Hubendick, but lacking the same degree of exposure tolerance. In places there are shells resembling the "var. *denticulata*" figured from the same locality (Hubendick 1946). There is a colony of "var. *scabra*" at the sheltered eastern end of the West Head, and another in what is probably the most sheltered part of the West Arm, in that the swirl of the tide does not impinge directly upon it.

Siphonaria tasmanica Tenison-Woods occurs in the entrance to the lagoon at Pipe Clay Lagoon, but this appears to be its nearest approach to a fully sheltered area. However, it also occurs in D'Entrecastreau Channel near Dover (Guiler 1952 *a*), where the shelter is considerable. It also occurs on the west side of the Nut, at Stanley, north-west Tasmania, where there is considerable exposure though not oceanic. There are certain broad resemblances between the sheltered areas in the Channel in southern Tasmania and probably other bays there, with the exposed shores of the North Coast, but the writer feels that no more significance should be attached to this than is attached to the usual tendency to find as one moves south in eastern Australia that there is a seeking out of greater shelter. *S. tasmanica* is also a constituent of the fauna at Trial Harbour, West Coast, where it is common, but less so than *S. diemenensis*. There is a subspecies, *S. tasmanica turrita* Iredale 1940, but one is unable to find evidence that this is more than a variety.

The third species, *Siphonaria funiculata* Reeve, easily recognisable by its very fine ribs, has been found in places of oceanic exposure on the East Coast. It also occurs in Oyster Bay, and young specimens were found in Coles Bay. On the North Coast it has been found at Bridport, but not elsewhere by the writer. It appears to be moderately common in the East, and probably the same may be said of the South.

NOTES ON INDIVIDUAL SPECIES.

Modiolus pulex (Lamarck).

Laseron (1956) has recently reviewed the New South Wales Mussels, and in the light of his findings it will be of interest to record here some

of the writer's observations. *Modiolus pulex* is widely distributed in Tasmania and occurs at Trial Harbour. On exposed coasts, where it occurs with *Austromytilus rostratus*, it is a minor constituent of the fauna. On the North Coast, however, it comes into its own. It is on these shores the following observations were made. The most notable development of the species is that on the granite boulders at Bridport (Kershaw 1957). Here the species dominates the Midlittoral at the expense of the barnacles. In several places *Galeolaria* is also present. No doubt this occurrence is very similar to that in western Victoria and South Australia rather than anything in other parts of Tasmania. It seems possible that a mild climate with a small amount of shelter but yet considerable wave action may be a factor in accounting for the phenomenon.

On other parts of the North Coast the shells are generally very much smaller, and may be confined to a narrow band at the lowest part of the Barnacle Belt, just above the Patelloids. This is particularly noticeable at West Head (Kershaw 1957), but the shells are somewhat larger in some localities further along the North-west Coast. May (1923) has figured a shell from "brackish water estuaries" as *M. confusus* (Angas), but shells as large as this are not common, at least in North Coast localities. The shells found in the West Arm of the Tamar River, for example, are of the same size and appearance as shells from Bridport on the average. Among them, however, are occasional much larger shells of slightly different shape, which could be labelled *M. confusus*. There is not sufficient scientific evidence to substantiate the separation of an estuarine shell as a separate species. A series of forms shows reactions to their respective environments. As Laseron (*loc. cit.*) points out, these forms are not even racial. The large shells are apparently specimens which for some reason have made very vigorous growth. There is no point in retaining the name *M. confusus* in Tasmania.

Modiolus cottoni Laseron.

This is the species which the writer (1955) recorded as *M. spatula* Lamarck, but which he could not regard as satisfactory. In the writer's opinion, Lamarck used the word "spatule" in a descriptive sense without intending to name the "variety," but one is not in possession of all the facts. Iredale (1924) quoted Tate's words concerning a var. *spatula* Lamarck, and this seemed the only name available. Cotton and Godfrey (1938) and Laseron (*loc. cit.*) have also quoted Tate's words, but presumably the name has no value. As Laseron has provided a new name for shells which he states cannot be separated from eastern Tasmanian shells, it is proposed to discard *M. spatula* from the Tasmanian List in favour of Laseron's name. As it happens, the writer was fortunate enough to obtain a juvenile specimen alive on the rocks at Bridport. This situation was a small pool in the *Modiolus pulex* belt on the jagged metamorphosed Silurian series (not the granite), which make up the rocky shore at Bridport. An adult specimen was also found, but this was dead. These shells show that the species (as Laseron believes) is hirsute, and the hairs are not forked. May's (1923) figure is not a good one, and the writer's shells are not precisely identical with Laseron's figure. The differences are probably accounted for in both cases by the fact that the shells are from the North Coast, and not the East Coast. Cotton (1957) figures an hirsute South Australian shell.

Modiolus delinificus Iredale.

Laseron (*loc. cit.*) accepts this name in place of *M. albicostus* Lamarck, and it is intended to do likewise, as the type is May's shell (1923). It is mentioned here because it is found on sandy beaches (May states "many beaches"), although as the writer has not found it alive he assumes that it lives below low tide in Tasmania also. Laseron is hardly correct in confining it to ocean beaches, for one has found it in Prosser Bay, which certainly faces the Pacific, and on the North Coast, which does not. Presumably "ocean" is a pen slip for May's word "many."

Venerupis crenata Lamarck.

This is an example of a northern shell which is found in very sheltered waters in northern Tasmania. Very many examples have been studied *in situ* in the West Arm, Tamar River, and in not one instance could it be claimed that there was evidence that the mollusc had itself bored the hole in which it was found. The rock is a Permian pebbly mudstone or normal mudstone on various parts of the shore. Where pebbles have been removed by erosion, or where joints occur, the resulting cavities have been infilled with mud. In such places *Venerupis crenata* is commonly found. Distortion is common, but there are two noticeable forms of this which may be spoken of respectively as an elongate, more or less normal form, and an abbreviated form which tends to obesity.

Austrocochlea constricta (Lamarck).

There is some doubt as to the status of this species and *A. obtusa* (Dillwyn), with the suggestion that one of these may have only subspecific or varietal value. Endean, Kenny, and Stephenson (1956) have placed *A. obtusa* as a subspecies of *A. constricta*, but this seems unnecessary as *A. obtusa* has priority by several years, although *A. constricta* happens to be type species of the genus. In Tasmania these shells occupy two types of habitat, which only appear to overlap in certain places, such as the Tamar Estuary. As there is some variation throughout the group of forms sometimes included in *Austrocochlea*, it may be of interest to review the occurrence of the various species as they appear in the Tamar Estuary, and the headland, West Head, near the mouth.

West Head (see Kershaw 1957) is an exposed North Coast rocky shore. The most plentiful *Austrocochlea* is *A. constricta*, which is common on exposed Tasmanian shores, and is found over most of the shore. It appears first high in the Midlittoral, and is soon accompanied by *A. (Fractamilla) concamerata* (Wood). *Fractamilla* is now being given generic status by some. This species occurs on this part of the shore as a large shell with a prominent apex. At the foot of the Midlittoral at West Head, this form is not found alive, but another form takes its place. This second form is much smaller, and the apex is flattened, and will be termed "Form 2" for convenience. In this same part of the shore there is also found *A. (Chlorodiloma) odontis* (Wood), while perhaps in general slightly lower still, *A. (C.) adelaidae* (Philippi) is rather less common than its congener.

At Kelso-north, inside the estuary, *A. constricta* appears in small numbers well down in the Midlittoral, and may be found as far as the north end of Kelso Bay, but very rarely further, probably only accidentally. At the same time, *A. obtusa* appears on the sand flats in numbers over most of

the Midlittoral. The shell found here is a small form, about half normal size, and is probably the estuarine form of the species. In Kelso Bay this form becomes very common on the *Zostera* beds. At the south end of Kelso Bay there is a small outcrop of rock. At this point the rock fauna has shown a marked alteration to sheltered forms. The prominent *Austrocochlea* is now Form 2 of *concamerata* and the shell is very similar in general appearance except that it is now normally double the size of the normal West Head individuals, and the colours differ. In these areas, *A. odontis* is also present.

In the West Arm the upper shore has the estuarine form of *A. obtusa* with numbers of smaller shells which may be juveniles, while lower on the shore are shells which are near the normal form of *A. obtusa* in Tasmania. These are not as big as the bay shells of the East Coast nor as colourful. It is interesting to note that among shells from Boat Harbour, East Coast, both forms of *A. obtusa* appear, while the large Form 2 of *A. comcamerata* appears with a smaller shell very similar to what could have been called Form 1 of this species from West Head, although there is considerable difference in size in the specimens to hand. The "normal" *A. obtusa* from Boat Harbour distinctly recalls striped New South Wales shells. At Prosser Bay *A. obtusa* grows larger still, about one inch, and has a distinctive red tinge in this sandy East Coast bay. Variation of colour and pattern are normally expected with this species, so that the only noticeable point is the general drabness of estuarine specimens. It is doubtful whether this species ever occurs in one position in Tasmania in such numbers as appear in New South Wales.

Subninella undulata (Solander).

In Tasmania this species has two forms which are interesting from an ecological point of view, as one appears to occur mostly in exposed situations, while the other favours some shelter. The exposed shell is heavier and stronger, with elevated apex, well known in Tasmania, particularly on the East Coast. The form favouring some shelter (e.g., no more than is found at Kelso-north, Tamar River) is very like the common South Australian *Subninella undulata,* but never grows so large in Tasmania as far as the writer knows. Dr. Guiler obtained this form at Trial Harbour on the West Coast.

Lepsithais vinosa (Lamarck).

It is well known that this species is variable, hence it is of interest to find that certain variations appear to occur in definite situations. The writer has found that one form occurs only in sheltered places, and another in exposed places on all coasts in Tasmania from which shells have so far been examined. Hence it has been possible to refer to an exposed form and a sheltered form in field notes. It may be that other variations will become apparent.

INTERTIDAL MOLLUSCS OF CERTAIN LOCALITIES ON TASMANIAN COASTS.

Before presenting a tabular summary of the more important species studied, the localities at which they were observed are discussed. In the list of references at the end of this paper attention is drawn to various essays by Guiler relating to southern and eastern Tasmanian localities. Reference should be made to these for details not mentioned here.

West Coast.

As Dr. Guiler's results from Trial Harbour are not published, he kindly allowed the writer to make use of his molluscan collections in this work. Brief comment on these may be made at this point. Trial Harbour is on the West Tasmanian coast, somewhat south of the Pieman River. The rocks in the vicinity include Palaeozoic granite and Cainozoic sediments. The mollusca collected indicate two types of fauna, an exposed and a semi-exposed fauna, and these were obtained at two different places. Both groups are related to faunas from other parts of Tasmania and little individuality is noticeable. There is a suggestion of Flindersian influence, which is to be expected.

There are several species additional to those found on the North Coast, but these are such as would be expected on an oceanic coast, and are mostly present on the East Coast. One point of interest is the presence of *Austromytilus rostratus* in the exposed area and *Austromytilus erosus* in the more or less sheltered area. *A. rostratus* is an ocean coast species, but *A. erosus* occurs in semi-sheltered waters in the North and sheltered water in the East. *Patellanax chapmani* (T.-Woods) occurs in both areas and is recorded from the North Coast, but appears to be absent on the East.

North Coast.

At Stanley, collections were made on the massive dolerite headland known as the Nut. The western aspect grades from semi-exposed to exposed, with considerable wave action. Thus *Melaraphe* is hardly present as a belt at first, but becomes increasingly important until it is well developed over a considerable distance, particularly on vertical rock faces furthest out on the headland. There is a suggestion of relationship to the fauna of more exposed coasts with the presence of *Siphonaria tasmanica* and *Notoacmea petterdi*, the former absent and the latter rather rare further east on the North Coast. *Modiolus pulex* is not particularly well developed, but was found to be very plentiful near Wynyard further east. On the eastern aspect of the Nut, the exposure grades into much more shelter, and muddy flats occur with *Salinator solida* and *Anapella pinguis*, followed by scores of the little soldier crab *Mictyris platycheles*. East of this point a wide sandy beach develops with appropriate fauna. The North Coast appears to be distinguished by the presence of such species as *Uber aulacoglossa* (Naticidae), *Laternula creccina* (Laternulidae), *Eucrassatella kingicola* (Crassatellidae), *Venerupis galactites* (Veneridae), *Amphidesma nitida* (where more shelter), and these appear to be absent on other sandy shores.

West Head has been described by the writer (1957), and Green's Beach east of the headland is similar to that at Stanley, except that *Eucrassatella kingicola* may not be present.

One has already referred frequently to localities within the Tamar River. These grade from semi-exposure to sheltered to very sheltered waters. Wide sand flats alternate with considerable areas of dolerite shingle north of Kelso. *Zostera nana* forms a wide belt on the sand, and is commonly seen at many places in the Estuary towards Launceston. Kelso Bay, south of Kelso, has a wide *Zostera* belt with numerous *Austrocochlea*

obtusa, etc., and passes into very sheltered mud flats with *Salinator solida* at one point, while at another a fresh water spring ensures the presence of a small population of *Ophicardelus ornatus*. At the southern end an outcrop of Permian till shows the effect of a small degree of exposure with the re-development of the more northern fauna (Tamar) and the presence of a *Melaraphe* belt. South of this point the shore shows a marked estuarine trend.

West Arm is several miles within the estuary near Beauty Point, and is very sheltered, with very small wave action. There are mud and sand flats, with Permian mudstone platforms. The geology has been reviewed by the writer (1955). There is a good deal of resemblance to Pipe Clay Lagoon (Guiler 1951) and a direct comparison is made between these two localities in Table 2. The presence of the mudstone platforms, however, introduces an additional element, for there is little by way of firm substratum in the southern locality. At West Arm *Venerupis crenata* and *Onchidella patelloides* are numerous and assist in adding individuality to this locality. *Velecumantus australis* is very numerous, and is the dominent species on parts of the shore. It is present in Kelso Bay and on parts of the East Coast in shelter. It is more common again at Port Arthur, where there are very sheltered mud flats, and is present in Pipe Clay Lagoon. In West Arm at one point there is an important occurrence of *Galeolaria caespitosa*, the tubes of which provide much shelter and are favoured by *Onchidella*. A curious feature of the West Arm is the tolerance of its fauna to considerable variation in salinity, and sometimes to turbidity. The crab *Mictyris* is also numerous here.

At Bridport several types of shore exist. The Brid and Forester Rivers form a small estuary, which widens near the mouth into a small sandy bay. Above the beach there is some marshy ground, with pools where *Salinator solida* is present. East of the mouth there is unbroken sandy beach, while to the west the beach is littered with granite boulders, some of large size. Further west there is a rocky shore of Silurian metamorphic sediments. A feature of the rocky shores is the development of *Modiolus pulex*. The sandy beach is distinguished by the presence of considerable numbers of *Cardium racketti* and *Glycymeris* (*striatularis*) *suspectus* Iredale, which is in reduced numbers westerly. *Glycymeris flabellatus* Tenison-Woods also appears here. Another important North Coast bivalve which appears here is *Macoma deltoidalis* (Family Tellinidae), which is more common in sheltered areas, such as West Arm, than on the exposed beaches, where it lives lower on the shore.

East Coast.

Ocean beaches bring a considerable increase in the numbers of *Glycymeris suspectus*, so that dead valves are extremely common. The species has its habitat principally below low tide level, and is mentioned only because it is so common. All Tasmanian sandy beaches with any degree of wave action are distinguished by the presence of *Uber conicum*, *Amphidesma spp.*, *Austromactra rufescens*, *Tawera gallinula* associated with *Katelysia scalarina*, *Flavomala biradiata*, *Anapella pinguis*, etc., the last named species becoming more common with shelter. Species deserving notice in addition to those listed in Table 2 are *Solen vaginoides Callanaitis disjecta* and *Placamen placidum*. The last-named is commonly observed alive on exposed

beaches. It is probably a dominent or co-dominant of the lowest Midlittoral of some shores.

George's Bay at St. Helens is a sheltered bay, the flooded south of the river, with wide tidal mudflats. Another such muddy estuary is Little Swan Port. These have typical sheltered faunas which do not here need elaboration. East Coast lagoons are similar on a smaller scale, with the difference that these commonly have a marshy salt flat with volunteer succulents and a population of *Salinator solida* in the Supra-littoral, while the dominant Midlittoral bivalve is *Anapella pinguis*.

A fully exposed quartzite reef was examined on the sandy shore near Scamander. The dominant midlittoral mollusc was *Austromytilus rostratus* forming a dense mat on the side of the rock face, and hence not bearing the full brunt of the wave action. On a flat surface at a lower level the surf barnacle *Catophragmus polymeris* was conspicuous. Patelloids observed included *Cellana solida, C. tramoserica, Siphonaria tasmanica, S. funiculata.* There was no *Melaraphe* belt, but some individuals adhered to the mussels. The highest species was the barnacle, *Chthamalus antennatus*, as the summit of the rock surface in any case probably did not reach the Supralittoral Fringe. In addition, the smooth rock surface made it unsuitable for *Melaraphe*.

At Bicheno the shore is of massive granite, the smooth surface of which is pounded by oceanic wave action. *Melaraphe unifasciata* individuals are very robust, but not plentiful. The upper shore has few individuals, but *Sypharochiton maugeanus* and *Austrocochlea concamerata* were observed near the top of the barnacle belt. *Austromytilus rostratus* follows and subsequently the Patelloids. The shore from the lower parts of the Barnacle Belt rapidly gains in numbers of species and individuals until there are dense populations in which the usual molluscs are ingredients.

In Oyster Bay the rocky shore of dolerite has dense populations of *Austromytilus rostratus*. The most noticeable point with reduction in exposure is the absence of the surf barnacle *Catophragmus*. So far as molluscs are concerned, there are generally more individuals on the higher parts of the shore. However, this generalisation does not apply in some places. On the granite of Cole's Bay, with even less exposure, there are markedly fewer *Austromytilus*, but many more gastropods in the Midlittoral

At Orford, Prosser Bay, the sandy shore yielded a large number of bivalves, and a number of large *Austrocochlea obtusa*. *Katelysia corrugata* and *Eumarcia fumigata* become more noticeable members of the fauna, but there is a more noticeable southern influence in the sub-tidal fauna of bivalves.

At Eagle Hawk Neck there is a sheltered sandy shore fauna on the western side, and an exposed fauna on the East. This, of course, applies also to the rocky shores which are of dolerite and mudstone. At Dunalley the sheltered sandy shore fauna is again present. The sheltered shore species, which may be very common in such places, are rare on the surf beaches.

South Coast.

In the Port Arthur area there is a range of conditions from maximum shelter to maximum exposure at, say, Cape Pillar. At Port Arthur the "sheltered" bivalves *Anapella pinguis* and *Katelysis scalarina* are again part

of the fauna. *Velacumantus australis* is present on the mud surface. The area has been dealt with by Cribb (1954) from an algal point of view, and he deals in a general way with the fauna. Despite the apparent shelter, Port Arthur is similar to Cole's Bay in possessing a semi-exposed molluscan fauna. Thus there are found *Cellana solida, Siphonaria tasmanica, S. diemenensis Notohaliotis ruber,* while *Austromytilus rostratus* packs fissures and below these *Mytilus planulatus* is also present. At Point Puer the dolerite rocks are semi-exposed, and support a typical fauna, such as is present on all coasts, showing some degree of exposure and wave action (typified by the presence of a defined *Melaraphe* Belt). Guiler (1952 *b*) has given brief notes on this locality, and the writer has had the opportunity of studying the molluscs collected here by him. The species are those found on the East Coast, but *Fossarina petterdi* and the bivalve *Hiatella australis* may be mentioned.

The sandy shores of Frederich Henry Bay have considerable shelter near Dunalley, but near the entrance to Pipe Clay Lagoon a typical sandy exposed beach fauna was obtained with the addition of *Psammobia livida* and *Electromactra flindersi,* but without *Callanaitis disjecta.* A similar fauna exists at Sandy Bay near Hobart, and here *Katelysia scalarina* and *K. corrugata* are robust shells. *Venerupis diemenensis* is also an addition on these southern shores.

The rock faunas of the Derwent area and D'Entrecastreau Channel bays have been dealt with by Guiler (1950, 1952 *a*) and South Cape Bay (1954 *b*). This latter area has a high degree of exposure, but the usual molluscs are present, although *Melaraphe* is hardly developed as a belt, which is due to the nature of the platform and the absence of a Supra-littoral Fringe as such. *Siphonaria diemenensis* is apparently especially plentiful, and is accompanied by *S. tasmanica,* but *Cellana solida* is rare in some places. Guiler (1954 *b*) has reported on a rather different type of shore in the South Cape Bay localities in that algae dominate the intertidal area. It is therefore a pity that no molluscs are available from points further west, because if differences from the typical Tasmanian molluscan fauna exist, they will be found in the south-west corner.

A tabular summary of the species is presented in Table 2, where abbreviations are used as follows:—Supralittoral Fringe (S.L.F.), Midlittoral (ML), Infralittoral Fringe (ILF), Dominant (D), Common (C), Present (P), Victoria (V), New South Wales (N), South Australia (S), and Queensland (Q).

The nature of the substratum is noted briefly after each species name. Occurrences in mainland States are included for comparison.

TABLE 2.

Principal species of Mollusca found on Tasmanian shores.

Gastropoda. Species and substrate.	Place on Shore	West Exposed	West Semi-exposed	North Exposed	North Semi-exposed	North Sheltered	East Exposed	East Semi-exposed	East Sheltered	South Exposed	South Semi-exposed	South Sheltered	Max. Shelt. West Arm	Max. Shelt. Pipe Clay Lagoon	Max. Shelt. East Coast Lagn.	Victoria	South Australia	New South Wales	South Queensland
Haliotidae																			
Notohaliotis ruber	ILF	P	...	C	...	...	P	C	...	P	P	...	...	...	...	V	S	N	...
(Leach) rocks																			
Scissurellidae																			
Scissurella ornata	ILF	...	...	...	...	...	P	...	...	P	...	...	...	...	...	...	...	N	...
May algae																			
Fissurellidae																			
Scutus antipodes	ML	...	...	P	...	...	P	...	...	P	...	...	...	...	...	V	...	N	Q
Montfort rocks																			
Montfortula conoidea	ML	...	...	C	P	...	...	C	...	...	C	...	...	...	...	V	S	—	Q
(Reeve) rocks (*Galeolaria* Belt)																			
Montfortula rugosa	ML	P	...	P	...	...	...	P	...	...	...	...	...	...	...	V	S	...	...
(Quoy and Gaimard) rocks, (*Gal.* Belt)																			
Sophismelepas nigrita	ILF	...	...	P	...	...	...	...	...	...	...	...	...	...	...	V	S	N	...
(Sowerby) rocks																			
Patellidae																			
Patellanax peroni	ILF	C	...	P	...	...	C	...	...	...	...	...	...	...	...	V	S	N	...
(Blainville) rocks																			
P. chapmani	ILF	P	P	P	...	...	...	...	...	...	...	...	...	...	...	V	S	...	...
(T. Woods) rocks																			
P. victoriana	ILF	P	...	...	...	...	...	...	...	P	...	...	...	...	...	V	S	...	...
Singleton rocks																			
Cellana solida	ML	C	...	D	...	...	C	P	P	C	P	P	...	...	...	V	S	...	...
(Blainville) rocks (Patelloid Belt)																			
C. tramoserica	ML	...	...	P	...	...	P	...	...	...	...	...	...	...	...	V	S	N	Q
(Sowerby) rocks																			

		West		North			East			South			Max. Shelt.						
	Place on Shore	Exposed	Semi-exposed	Exposed	Semi-exposed	Sheltered	Exposed	Semi-exposed	Sheltered	Exposed	Semi-exposed	Sheltered	West Arm	Pipe Clay Lagoon	East Coast Lagn.	Victoria	South Australia	New South Wales	South Queensland
Acmeidae																			
Patelloida alticostata (Angas) rocks	ML	...	P	C	P	...	P	C	...	P	P	P	...	...	...	V	S	N	...
P. latistrigata (Angas) rocks (Patelloid Belt)	ML	P	...	P	...	...	P	...	...	P	...	...	...	...	...	V	S	...	...
Chiazacmea flammea (Quoy and Gaimard) rocks	ML	...	...	...	P	...	...	P	...	...	...	P	...	...	...	V	...	N	...
Notoacmea mayi (May) rocks	ML	...	P	...	...	...	P	P	...	...	P	...	...	...	...	V	...	...	...
Notoacmea petterdi (T. Woods) rocks	ML	P	...	P	...	...	C	...	...	...	P	...	...	...	...	V	...	N	Q
Notoacmea scabrilirata (Angas) rocks	ML	...	P	...	...	...	...	...	P	...	...	P	C	...	...	V	S	N	...
Conacmaea corrosa Oliver rocks	ML	...	...	...	...	...	...	...	...	P	P	...	...	...	...	...	...	...	...
C. subundulata (Angas) rocks	ML	P	...	C	P	...	...	...	...	...	...	P	...	C	...	...	S	N	...
Actinoleuca calamus (Crosse and Fischer) rocks	ILF	P	...	P	P	...	P	...	...	P	...	...	...	...	...	V	S	...	...
Trochidae																			
Macroclanculus undatus (Lamarck) rocks	ILF	...	...	P	...	...	...	C	...	...	P	...	...	...	...	V	S	N	...
Mesoclanculus plebejus (Philippi) rocks	ILF	...	...	C	...	...	...	C	...	...	C	...	...	...	...	V	S	N	...
Phasianotrochus eximius (Perry) algae	ILF	...	...	C	...	...	...	C	...	...	C	...	...	...	...	V	S	N	...

Phasianotrochus bellulus (Dunker) algae	ILF	...	...	C	...	...	...	C	...	...	...	...	...	...	...	V	S	...	...
Thalotia conica (Gray) algae	ILF	...	...	P	C	...	...	...	...	...	...	...	...	...	...	V	S	...	...
Bankivia fasciata (Menke) algae	ILF	...	...	C	...	...	C	...	...	C	...	...	...	...	...	V	S	N	...
Austrocochlea obtusa (Dillwyn) sand, mud	ML	...	P	...	P	D	...	...	C	...	...	C	C	D	C	V	...	N	Q
A. constricta (Lamarck) rocks	ML	...	...	C	P	...	C	...	...	C	C	...	...	...	...	V	...	...	...
Fractamilla concamerata (Wood) rocks	ML	...	P	C	C	...	C	C	C	C	...	...	...	...	...	V	S	N	...
Chlorodiloma odontis (Wood) rocks	ML	P	...	C	P	...	C	C	...	...	P	P	...	...	...	V	S	...	...
C. adelaidae (Philippi) rocks	ILF	...	...	P	P	...	P	...	...	...	...	...	...	...	...	V	S	...	...
Fossarina legrandi (Petterd) rocks	ILF	P	...	...	...	...	P	...	...	P	...	...	...	...	...	V	S	N	...
F. petterdi (Crosse) rocks	ILF	P	...	...	...	...	...	...	...	C	C	...	...	...	...	V	S	...	...
Stomatellidae																			
Herpetopoma baccata (Menke) rocks	ILF	...	...	P	...	...	...	P	...	...	...	...	...	...	...	V	...	N	...
Turbinidae																			
Subninella undulata (Solander) rocks, sand	ML	P	...	C	C	...	P	C	...	P	C	...	...	...	...	V	S	N	Q
Micrastraea aurea (Jonas) rocks	ML	...	P	C	...	...	...	P	...	...	P	...	...	...	...	V	S	...	...
Eutropidae																			
Phasianella australis (Gmelin) algae	ILF	...	...	C	C	...	...	C	...	...	C	C	...	...	...	V	S	...	...
Mimelenchus ventricosa (Swainson) algae	ILF	...	...	C	...	...	...	...	...	...	...	...	...	...	...	V	S	N	...
Neritidae																			
Melanerita melanotragus (Smith) rocks	ML	P	...	D	P	...	...	P	...	...	...	...	...	...	...	V	S	N	Q

	Place on Shore	West Exposed	West Semi-exposed	North Exposed	North Semi-exposed	North Sheltered	East Exposed	East Semi-exposed	East Sheltered	South Exposed	South Semi-exposed	South Sheltered	Max. Shelt. West Arm	Max. Shelt. Pipe Clay Lagoon	Max. Shelt. East Coast Lagn.	Victoria	South Australia	New South Wales	South Queensland
Littorinidae																			
Melaraphe unifasciata (Gray) rocks	SLF	D	...	D	P	P	D	P	...	D	P	...	P	...	...	V	S	N	Q
M. praetermissa (May) rocks	SLF	...	...	P	...	...	P	...	...	P	...	...	—	...	...	V	S	...	...
Bembiciidae																			
Bembicium melanostomam (Gmelin) rocks	ML		...	...	P	...	...	P	...	...	...	C	...	...	...	V	S	N	Q
B. auratum (Quoy and Gaimard) rocks	ML	...	...	...	...	P	...	...	P	...	...	P	D	P	...	V	...	N	...
B. nanum (Lamarck) rocks	ML	P	...	C	P	...	C	P	...	P	P	...	...	...	...	V	S	...	...
Assiminidae																			
Assiminia brazieri (T. Woods) mud, rocks	ML	...		...	C	C	...	...	P	...		...	C	D	P	V	S	...	...
Vermetidae																			
Serpulorbis sipho (Lamarck) rocks, stones	ILF	...	P	...	P	...	...	P	...	...	...	...	...	...	...	V	S	N	...
Cerithidae																			
Zeacumantus diemenensis (Quoy and Gaimard) sandy mud	ML	...	P	...	C	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Fubittium lawleyanum (Crosse) sandy mud	ML	...	...	...	C	D	...			...	...	...	D	D	P	V	S	...	...
Cacozeliana granarium (Kiener) sand	ML	...	...	...	D	...	...	...	...	...		...	...	...	...	V	S	...	...
Velacumantus australis (Quoy and Gaimard) mud	ML	...	...	...	P	P	...	...	P	...	...	P	D	P	...	V	...	...	...

Hipponicidae																			
Sabia conica (Schumacher) shells, etc.	ILF	...	P	P	P	...	P	P	...	...	...	...	...	...	...	...	S	...	...
Naticidae																			
Uber aulacoglossa (Pilsbry and Vanatta) sand	ML	...	...	P	P	...	...	...	...	...	...	...	P	...	...	V	S	N	...
Uber conicum (Lamarck) sand	ML	P	...	C	C	...	P	C	...	...	C	...	...	P	...	V	S	N	Q
Ectosinum zonale (Quoy and Gaimard) sand	ILF	...	...	P	...	...	...	P	...	...	...	...	...	...	...	V	S	N	...
Cymatiidae																			
Cymatilesta barthelemyi (Bernardi) rocks	ILF	...	...	P	...	...	P	P	...	...	...	...	...	...	...	...	...	...	...
Charonia rubicunda (Perry) rocks	ILF	...	...	...	...	...	...	P	...	...	...	...	...	...	...	...	...	N	...
Negyrina subdistorta (Lamarck) rocks	ML	...	...	P	...	...	...	...	...	...	...	...	...	...	...	V	S	...	...
Cymatiella verrucosa (Reeve) rocks	ILF	...	P	P	...	...	...	...	...	...	...	...	...	...	...	V	S	...	...
Muricidae																			
Pterynotus triformis (Reeve) rocks	ILF	...	...	C	P	...	...	P	...	...	...	...	...	...	...	V	S	...	...
Galfridus eburneus (Petterd) rocks	ILF	...	...	P	...	...	...	P	...	...	...	...	...	...	...	V	S	...	...
Thaididae																			
Dicathais orbita (Gmelin) rocks	ILF	...	...	P	...	...	C	C	...	...	...	...	...	...	...	V	...	N	Q
D. textiliosa (Lamarck) rocks	ILF	P	...	C	...	...	...	...	...	...	...	...	...	...	...	V	S	...	...
Neothais baileyana (T. Woods) rocks	ML	...	...	P	...	...	...	...	...	P	...	...	...	...	...	V	S	...	...
Lepsithais vinosa (Blainville) rocks	ML	P	P	C	C	C	C	P	P	...	P	...	C	...	...	V	S	N	...
Lepsiella reticulata (Lamarck) rocks	ML	...	...	...	...	...	C	...	...	...	P	...	...	...	...	V	S	...	...

	Place on Shore	West Exposed	West Semi-exposed	North Exposed	North Semi-exposed	North Sheltered	East Exposed	East Semi-exposed	East Sheltered	South Exposed	South Semi-exposed	South Sheltered	Max. Shelt. West Arm	Max. Shelt. Pipe Clay Lagoon	Max. Shelt. East Coast Lagn.	Victoria	South Australia	New South Wales	South Queensland
Agnewia tritoniformis (Blainville) rocks	ML			P				P			P					V		N	
Pyrenidae																			
Zemitrella semiconvexa (Lamarck) rocks	ILF			C	P			P								V		N	
Zemitrella lincolnensis (Reeve) rocks	ILF			P				P			P					V	S	N	
Z. tayloriana (Reeve) rocks	ILF							P	P		P							N	
Z. vincta (Tate) rocks	ILF			P				P			P					V	S		
Z. acuminata (Menke) rocks	ILF		P																
Zella beddomei (Petterd) rocks	ILF								P							V			
Buccinidae																			
Cominella eburnea (Reeve) rock, sand	ML				C			C								V	S		
C. lineolata (Lamarck) rock, sand, *Zostera*	ML	P	P	C	C	C	C	C	C	C	C	C	P	P		V	S		
C. acutinodosa (Reeve) sand, mud	ML				C	P							P			V	S		
Tasmeuthria clarkei (T. Wood) rocks	ILF										P					V	S		
Fax tenuicostata (T. Woods) rocks	ML	P					P			P									

Berylsma grandis (Gray) rocks	ILF	...	...	P	P	...	...	P	...	...	...	...	...	...	...	V	S	...	...
Nassariidae																			
Parcanassa burchardi (Philippi) sandy mud	ML	...	...	...	C	C	...	...	...	...	...	...	C	...	...	V	S	N	...
P. pauperata (Lamarck) sand, muddy sand	ML	...	...	...	C	C	...	...	C	...	...	P	P	C	...	V	S	N	...
Fasciolariidae																			
Pleuroploca australasiae (Perry) rock, sand	ML	...	...	P	P	...	...	C	...	...	C	...	P	C	...	V	...	N	...
P. coronata (Lamarck)	ML	...	...	C	C	P	...	...	...	...	...	...	...	...	...	V	S	N	...
Propefusus pyrulatus (Reeve) rocks	ML	...	...	P	...	...	...	...	...	...	...	...	...	...	...	V	...	N	...
P. undulatus (Perry) rocks	ML	...	...	P	...	...	...	...	...	...	P	P	...	...	...	V	...	...	...
Olividae																			
Alocospira marginata (Lamarck) sand	ILF	...	...	...	...	...	...	...	...	...	P	...	...	...	...	...	S	...	...
Alocospira oblonga (Sowerby) sand	ILF	...	...	P	...	...	...	...	...	...	...	...	...	...	...	V	...	...	...
Baryspira petterdi (Tate) sand	ILF	...	...	P	...	...	...	...	...	...	...	...	...	...	...	V	S	...	...
Mitridae																			
Mitra glabra Swainson rocks	ILF	...	...	P	...	...	...	P	...	...	...	...	...	...	...	V	S	N	...
Mitra rhodia Reeve rocks	ILF	...	P	P	...	...	...	...	...	...	...	...	...	...	...	V	S	N	...
Volutidae																			
Amorena undulata (Lamarck) sand	ILF	...	...	P	...	...	...	P	...	...	P	...	...	...	...	V	S	...	...
Lyria mitraeformis (Lamarck) sand	ILF	...	...	P	...	...	...	...	...	...	...	...	...	...	...	V	S	...	...
Marginellidae																			
Marginella formicula Lamarck sand	ILF	...	...	...	...	...	...	C	P	...	C	...	...	...	...	...	S	...	...

	Place on Shore	West Exposed	West Semi-exposed	North Exposed	North Semi-exposed	North Sheltered	East Exposed	East Semi-exposed	East Sheltered	South Exposed	South Semi-exposed	South Sheltered	Max. Shelt. West Arm	Max. Shelt. Pipe Clay Lagoon	Max. Shelt. East Coast Lagn.	Victoria	South Australia	New South Wales	South Queensland
M. muscaria	ILF	...	...	...	...	...	...	C	C	...	...	...	...	...	...	V	S	N	...
Lamarck sand																			
M. pygmaeoides	ILF	...	...	P	...	...	P	P	...	P	...	...	...	...	...	V	S	...	...
Singleton rocks																			
M. tasmanica	ILF	...	...	...	...	...	P	...	...	...	...	...	...	...	...	V	S	N	...
T. Woods sand																			
Turridae																			
Austrodrillia beraudiana	ILF	...	P	P	P	...	...	...	...	...	...	...	...	...	...	V	...	N	...
(Crosse) rocks																			
Conidae																			
Floraconus anemone	ILF	...	P	C	P	...	...	C	...	...	...	...	...	...	...	V	S	...	...
(Lamarck) rocks																			
Bullariidae																			
Quibulla tenuissima	ILF	...	...	P	P	...	...	P	...	...	...	...	...	...	...	V	S	N	...
(Sowerby) sand																			
Philinidae																			
Philine angasi	ILF	...	...	C	...	...	P	C	...	...	C	...	...	...	...	V	S	...	...
(Crosse and Fischer) sand																			
Elobiidae																			
Ophicardelus ornatus	SLF	...	...	...	...	P	...	...	P	...	...	...	C	...	...	V	S	N	...
(Ferussac) rock, muddy sand																			
Onchidiidae																			
Onchidella patelloides	ML	P	...	...	P	...	P	...	...	...	...	...	C	...	...	V	...	N	...
Quoy and Gaimard rocks																			

Amphibolidae																			
Salinator fragilis	ML	...	...	...	C	C	...	...	C	...	...	..	D	C	...	V	S	...	...
(Lamarck) muddy sand, *Zostera* Belt																			
S. solida	ILF	...	...	...	..	D	...	...	C	..	..		D	D	D	V	S	...	...
(Martens) mud, sand																			
Siphonariidae																			
Siphonaria diemenensis	ML	C	...	D	C	C	C	C	C	C	C	C	C	...	...	V	S	N	
Quoy and Gaimard rocks																			
Patelloid Belt																			
S. tasmanicus	ML	P	..	P	...	...	C	...	...	...	P	P	...	...	...	V	S	..	.
T. Woods rocks																			
S. funiculata	ML	...	...	P	...	...	P	P	P	...	...	P	.	...	...	...	S	...	.
Reeve rock																			
Pelecypoda																			
Arcidae																			
Arca pistachia	ILF	...	P	C	P	...	...	P	...	...	..	..	...	..	...	V	S	N	..
Lamarck rocks																			
Glycymeridae																			
Glycymeris (striatularis) suspectus	ILF	...	..	C	...	..	C	...	...	...	...	P	...	...	...	...	...	...	.
Iredale sand																			
Vulsellidae																			
Vulsella vulsella	ILF	...	..	P	...	...	...	P	...	...	...	...	..	...	...	...	...	N	..
(Linne) rocks (sponges)																			
Vulsella spongiarum	ILF	...	..	P	...	...	...	...	...	...	...	.	...	...	...	V	S	...	..
Lamarck rocks																			
Pinnidae																			
Atrina tasmanica	ILF	...	..	P	...	...	...	...	...	...	..	...	...	..	...	V	...	...	...
(T. Woods) sand																			
Pteriidae																			
Electroma georgiana	ILF	...	..	C	...	...	...	...	C	P	...	P	P	..	..	V	S	...	...
(Quoy and Gaimard) algae																			
Ostreidae																			
Ostrea angasi	ILF	...	...	...	..	P	...	...	...	P	..	..	P	P	...	...	...	N	...
Sowerby rock, mud																			

Species	Place on Shore	West: Exposed	West: Semi-exposed	North: Exposed	North: Semi-exposed	North: Sheltered	East: Exposed	East: Semi-exposed	East: Sheltered	South: Exposed	South: Semi-exposed	South: Sheltered	Max. Shelt.: West Arm	Max. Shelt.: Pipe Clay Lagoon	Max. Shelt.: East Coast Lagn.	Victoria	South Australia	New South Wales	South Queensland
Trigonidae																			
Neotrigonia margaritacea	ILF	...	...	...	P	P	...	...	P	P	...	...	...	...	...	V	...	N	...
(Lamarck) mud, sand																			
Pectinidae																			
Mimachlamys asperrima	ILF	...	...	...	P	P	...	...	P	...	...	...	P	...	...	V	S	N	...
(Lamarck) sand, sponges																			
Limidae																			
Pelecypoda																			
Species																			
Austrolima gemina	ILF	...	...	P	...	...	...	...	...	...	...	...	...	...	...	...	S	...	...
Iredale rocks																			
Anomiidae																			
Monia ione	ILF	...	...	P	...	...	...	P	...	...	P	...	...	...	...	V	S	N	...
Gray rocks																			
Mytillidae																			
Mytilus planulatus	ML	...	...	...	...	...	...	C	C	...	C	C	...	P	...	V	S	N	...
Lamarck rocks																			
Austromytilus rostratus	ML	C	...	...	...	...	D	D	...	D	D	...	...	P	...	V	S	N	...
(Dunker) rocks																			
A. erosus	ML	...	P	...	C	P	...	...	...	...	...	...	...	...	...	V	S	...	...
(Lamarck) rocks, sand																			
Modiolus delinificus		...	...	P	P	...	"	...	...	...	...	...	...	...	...	V	S	N	...
Iredale rocks? not taken alive																			
M. cottoni	ILF	...	P	P	...	...	...	...	...	...	...	...	...	...	...	V	S	N	...
Laseron rocks, 1 sp. Bridport alive																			

M. pulex	ML	P	P	D	P	C	P	...	...	...	...	...	D	...	...	V	S	N	...
(Lamarck) rocks																			
Laternulidae																			
Laternula creccina	ILF	...	...	P	C	...	...	...	...	...	...	...	...	...	...	V	S	N	...
(Reeve) mud, sand																			
L. tasmanica	ILF	...	...	...	...	...	...	...	...	...	...	P	C	...	...	...	...	...	...
(Reeve) mud																			
Crassetellidae																			
Eucrassatella kingicola	ILF	..	...	P	...	...	...	...	...	...	...	...	...	...	...	V	...	N	..
(Lamarck) sand																			
Leptonidae																			
Kellia australis	ML	P	...	C	P	P	P	...	...	C	P	P	...	...	...	V	S	N	..
(Lamarck) rocks																			
Luciniaae																			
Wallucina assimilis	ML	...	...	...	...	...	...	...	...	...	...	...	...	P	...	V	...	N	..
(Angas) sand																			
Cardiidae																			
Cardium racketti	ILF	...	...	C	P	...	...	P	...	...	P	..	...	...	...	V	S	N	..
Donovan sand																			
C. cygnorum	ILF	...	...	P	...	...	...	...	...	...	P	...	...	...	...	V	S	N	..
Deshayes sand																			
Veneridae																			
Dosinia coerulaea	ILF	...	...	C	...	...	P	P	...	...	P	...	...	...	...	V	...	N	...
(Reeve) sand																			
Paradione kingii	ILF	..	...	P	...	...	P	P	...	...	P	...	...	...	...	V	S	N	..
(Gray) sand, rare alive																			
Pelecypoda																			
Species																			
Paradione diemenensis	ILF	...	...	P	..	...	...	C	...	..	...	...	...	...	...	V	...	...	..
(Hanley) sand																			
Callanaitis disjecta	ILF	..	.	C	...	...	...	P	...	...	...	...	...	...	...	V	S	N	..
(Perry) sand																			
Placamen placidum	ML	...	...	C	...	...	C	C	...	...	P	..	...	...	...	V	S	...	...
(Philippi) sand																			
Tawera gallinula	ILF	...	...	C	P	..	C	C	...	...	...	...	...	...	...	V	S	N	..
(Lamarck) sand																			

	Place on Shore	West Exposed	West Semi-exposed	North Exposed	North Semi-exposed	North Sheltered	East Exposed	East Semi-exposed	East Sheltered	South Exposed	South Semi-exposed	South Sheltered	Max. Shelt. West Arm	Max. Shelt. Pipe Clay Lagoon	Max. Shelt. East Coast Lagn.	Victoria	South Australia	New South Wales	South Queensland
T. lagopus (Lamarck) sand	ILF	...	...	P	...	...	P	P	...	...	...	...	...	...	...	V	S	N	...
Venerupis exotica Lamarck sand	ILF	...	...	P	...	...	P	...	...	...	P	...	...	...	...	V	...	...	...
V. diemenensis Quoy and Gaimard sand	ILF	...	...	...	...	...	...	...	...	...	P	...	...	P	...	...	...	...	...
V. crenata Lamarck rock	ML	...	...	...	...	C	...	...	...	...	...	...	C	...	...	V	S	N	...
V. fabagella (Deshayes) sand	ILF	...	...	P	...	...	...	P	...	...	...	...	...	...	...	V	...	N	...
V. galactites (Lamarck) sand	ILF	...	...	P	P	...	...	...	...	...	...	...	...	...	...	V	S	N	...
Katelysia scalarina (Lamarck) sand, muddy sand	ML	...	...	P	P	C	P	P	P	...	...	C	D	D	P	V	S	N	...
K. peroni (Lamarck) sandy mud	ML	...	...	...	P	P	...	...	...	...	...	...	D	...	...	V	S	...	...
K. corrugata (Lamarck) sand	ML	...	...	...	...	...	P	...	...	...	...	C	...	D	...	...	S	...	...
Eumarcia fumigata (Sowerby) sand	ILF	...	...	P	...	...	...	P	...	...	P	...	...	...	...	V	S	N	...
Tellinidae																			
Tellina albinella (Lamarck) sand	ILF	...	...	P	...	...	...	P	...	...	P	...	...	...	...	V	S	N	...
Macoma deltoidalis (Lamarck) sand, sandy mud	ML	...	...	P	P	P	...	...	...	...	...	...	C	...	...	V	S	...	...

Psammobiidae																			
Flavomala biradiata (Wood) sand, sandy mud	ML	...	...	P	C	...	...	P	...	...	...	...	...	...	...	V	S	N	...
Psammobia livida Lamarck sand	ML	...	...	...	...	...	...	...	...	...	C	...	...	...	...	V	S	N	...
Solenidae																			
Solen vaginoides Lamarck sand	ILF	...	...	P	...	...	C	...	...	...	P	...	...	...	...	V	S	N	...
Mactridae																			
Mactra pura Deshayes sand	ILF	...	...	P	P	...	...	...	...	...	...	...	...	...	...	V	S	...	...
Austromactra rufescens (Lamarck) sand	ILF	...	...	P	...	...	...	C	...	...	P	...	...	P	...	V	S	...	...
Electromactra flindersi Cotton and Godfrey sand	ILF	...	...	...	...	...	...	...	...	...	P	...	...	...	...	...	S	...	...
Notospisula trigonella (Lamarck) sandy mud	ML	...	...	...	...	...	...	...	P	...	...	...	...	P	...	...	S	...	...
Anapella pinguis (Crosse and Fischer) sand, sandy mud	ML	...	...	P	C	...	...	P	D	...	...	P	...	D	D	V	S	...	...
Amphidesmatidae																			
Amphidesma angusta (Reeve) sand	ML	...	...	D	...	...	C	C	...	...	...	...	...	...	...	V	S	N	...
A. cuneata (Lamarck) sand	ML	...	...	...	...	...	...	P	...	...	...	...	...	...	...	V	S	N	...
A. erycinaea (Lamarck) sand	ML	...	...	...	...	...	...	P	...	...	P	...	...	...	...	V	...	...	...
A. nitida (Deshayes) mud	ML	...	...	...	...	P	...	...	...	...	...	...	...	P	...	V	...	...	...
Hiatellidae																			
Hiatella australis (Lamarck) rock	ILF	...	...	...	...	...	...	...	...	P	...	...	...	...	...	V	S	N	...
Crepipoda																			
Ischnochitonidae																			
Ischnochiton lineolatus (Blainville) rocks	ILF	...	...	P	...	...	P	...	...	...	P	...	...	...	...	V	S	...	...
I. elongatus (Blainville) rocks	ILF	...	P	C	...	...	C	...	...	C	...	...	...	...	...	V	S	...	...

	Place on Shore	West Exposed	West Semi-exposed	North Exposed	North Semi-exposed	North Sheltered	East Exposed	East Semi-exposed	East Sheltered	South Exposed	South Semi-exposed	South Sheltered	Max. Shelt. West Arm	Max. Shelt. Pipe Clay Lagoon	Max. Shelt. East Coast Lagn.	Victoria	South Australia	New South Wales	South Queensland
Heterozona subviridis Iredale and May rocks	ILF	P	...	...	...	...	P	...	...	...	...	P	...	...	...	V	S	...	...
Ovatoplax mayi (Pilsbry) rocks	ILF	...	...	...	...	...	P	...	...	...	...	...	...	...	...	V	S	...	...
Ischnoradsia eyanida (Sowerby) rocks	ML	...	...	...	...	...	P	...	...	P	...	...	...	...	...	...	...	...	...
I. novaehollandiae (Reeve)	ML	...	...	C	...	...	...	...	...	...	...	...	...	...	...	V	S	...	...
Cryptoconchidae																			
Acanthochiton sueurii (Blainville) rocks	ML	...	P	...	...	P	...	...	...	...	...	...	...	P	...	V	S	...	...
Plaxiphoridae																			
Poneroplax albida (Blainville) rocks	ML	...	...	P	...	...		P	...	.	...	...	...	...	...	V	S	...	...
P. costata (Blainville) rocks	ML	P	...	...	...	...	...	...	...	P	P	..	...	...	...	V	S	...	...
Chitonidae																			
Amaurochiton glaucus (Gray)	ML	...	...	...	...	...	...	...	...	...	C	C	...	...	...	...	...	...	...
Sypharochiton maugeanus Irelade and May rocks	ML	P	...	C	C	C	C	C	...	C	C	C	...	C	.	...	S	...	...

In Table 2 the distribution of species is according to the writer's knowledge, and is not necessarily complete. In indicating the place on the shore occupied by the various species, the writer has been guided by the presence of the particular species in a living condition in most cases. In a few instances a mollusc may be very rare alive in the tidal area and its true habitat may be only below tide marks. This applies in the case of certain bivalves.

Zoogeography.

A map showing the extent of the zoogeographical regions in Australia has been provided by Iredale (1937). In Table 2 the regional names have not been used, but State names inserted for convenience. According to Iredale, the Peronian Region extends from Southern Queensland to the East Coast of Tasmania. The Flindersian Region extends from Western Australia to the West Coast of Tasmania and includes the North Coast. A Maugean Sub-region includes the East Coast of Tasmania.

The writer holds that the Peronian Region has its affinities with the deep water mollusca of the East Coast, and this seems in accord with Iredale's opinion. The North Coast shows affinities with the Flindersian region, in some places strongly, but in general the reason for this is as much ecological as geographical. The Tasmanian aspect is too strong to be submerged by inclusion of this area in the Flindersian region without considerable qualification. Bennett and Pope (1953) suggested that the Maugean Province should be extended to include all Tasmania and the Victorian exposed coast. The writer is in accord with this opinion. Hence Tasmania is here suggested as representative of the Maugean Region with direct affinities with Victoria, particularly the exposed Victorian coast. Affinities with the Peronian Region exist in the East Coast fauna, especially in forms living below low tide. Affinities with the Flindersian Region exist on the West Coast and North Coast, being most noticeable in the forms between tides on the North Coast.

The Bass Strait area has not been discussed to any extent in this paper, but it seems that the Maugean Region should include the Bass Strait Islands. There are very noticeable Peronian influences on Flinders Island, and Flindersian on King Island.

Dr. Guiler has several times made observations concerning the relationships of the Tasmanian rocky shores to those of the Mainland (1951 *b*, 1952 *c*, 1954, 1955), and to those of New Zealand and South Africa (1952 *c*).

With few exceptions, the sandy shore molluscs living in Tasmania which are not found also in Victoria are peculiarly Tasmanian species. The writer has used the South Australian name for a south Tasmanian shell, *i.e.*, *Electromactra flindersi* Cotton and Godfrey. The Victorian shell is the Peronian *E. antecedens* Iredale, which is very closely related. Our shell may actually be this species, but without comparative material the matter is uncertain. *Laternula tasmanica* (Reeve) is the Tasmanian representative of the mainland *Laternula recta* (Reeve). There is not a great deal of difference between this species and the north Tasmanian form.

Cotton (in Crocker and Cotton 1946) summarised the main sand beach and estaurine beach shells of South Australia, and these compare closely with those of Tasmanian beaches. *Glycymeris radians* listed by

Cotton is, however, rare in the Tasmanian or Maugean Region. Of the estaurine shells, *Anapella adelaidae* and *Laternula recta* are not present here, This applies equally to *Assiminea granum* Menke. South Australian beaches have been treated generally by Johnston and Mawson (1946) and by Cotton and Godfrey (1938) and Cotton (1954 *b*). The most important difference which emerges is the presence of the "Pipi" *Plebidonax deltoides* (Lamarck) on the exposed beaches. This mollusc is present in similar situations in the Peronian Region. In New Zealand the "Toheroa," *Amphidesma ventricosum* Gray, is equivalent in occurrence and habitat to the "Pipi." In Tasmania, however, there appears to be no similar occurrence, and certainly nothing of economic value as are the above species. It is easy to show that Tasmanian species are related to or identical with Mainland species. It is on the Mainland rather than in Tasmania that different species appear in number, and different ecological features are indicated. This has been shown amply in the rocky shore faunal studies, and it should be expected on the sandy beach. It is less easy to show from sandy beach molluscs alone that Tasmania should be regarded as a distinct Region. In checking against New South Wales beach shells as detailed by Allan (1946), greater differences are observable. Several Tasmanian species are present, but in other cases the Tasmanian species are replaced by other species, *e.g.*, *Placamen molimen, Notospisula producta.*

On the New South Wales tidal flat (Allan 1947 *a*) *Pyrazus ebininus* and *Anadara trapezia* are significant. The first species lived here in Tasmania, and sub-fossil specimens are found, but its place is now taken by *Velacumantus australis,* which lies about on the tidal flat in a similar manner. *Anadara trapezia* probably did not extend south of the Bass Strait Islands in the past, but it still exists in Victoria. There seems to be no equivalent species in Tasmania. The southern *Katelysia spp., Macoma deltoidalis,* and *Anapella pinguis,* are replaced in New South Wales by *Paphia turgida, Proxichione matona, Circe sugillata,* etc., but it is of interest that *Flavomala biradiata, Laternula creccina* and *Ostrea angasi* are common to the two Regions.

Summary.

The more detailed information now available on the Tasmanian intertidal molluscan fauna has made possible a new appraisal of its relationships. It is closely comparable with the faunas of the nearby mainland coasts, and less so with the faunas of Western Australia, New South Wales and southern Queensland. There is little resemblance to the tropical Australian fauna, but some affinity with New Zealand is recognised. Contrasts on the Australian coast may well be as much due to facies as to any other factor.

The mollusca of the east and south-east coasts of Tasmania show Peronian affinities, while those of the north and west show Flindersian affinities. Moreover, Bass Strait is a faunal "cross roads," so sharp boundaries for the zoogeographic regions are not desirable there. Nevertheless, the Tasmanian fauna has an individuality of its own, which tends to indicate that a separate region should be recognised here. Hence the writer agrees with Bennett and Pope (1953) that a Maugan Biogeographical Province may suitably include all Tasmania, and, in addition, the exposed coast of Victoria.

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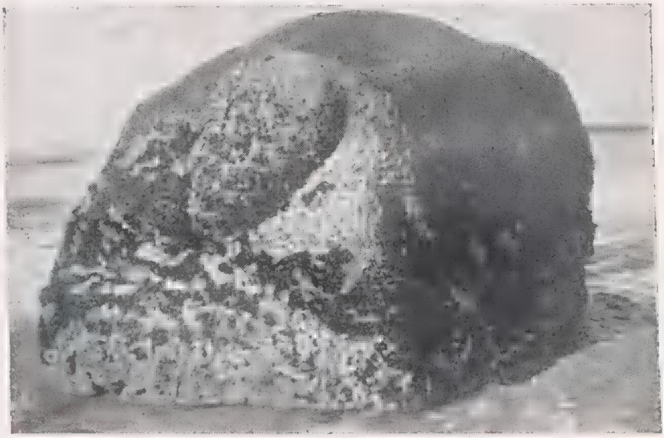

Text figure 2:
Granite boulders at Bridport, north-east Tasmania, showing belt of *Modiolus pulex* Lamarck (Black).

REFERENCES

ALLAN, JOYCE, 1946. Bivalve shells of a sandy ocean beach. *Aust. Mus. Mag.* 9 (1): 17-23.

————————., 1947*a*. Bivalve shells of a tidal flat. *Aust. Mus. Mag.* 9 (4): 122-126.

————————., 1947*b*. Bivalve shells of a tidal flat. II. *Aust. Mus. Mag.* 9 (5): 155-159.

————————., 1950. "Australian shells." Georgian House, Melbourne.

ASHBY, EDWIN, 1926. The regional distribution of Australian chitons (Polyplocophora). *Rep. Aust. Ass. Advanc. Sci.* 17: 366-393.

————————., and HULL, A. F. B., 1923. The Polyplocophora of King Island, Bass Strait. *Aust. Zool.* 3 (2): 79-84.

BENNETT, I., and POPE, E.C. 1953. Intertidal zonation of the exposed rocky shores of Victoria, together with a rearrangement of the biogeographical provinces of temperate Australian shores. *Aust. J. Mar. Freshw. Res.* 4 (1): 105-159.

COTTON, B. C., 1945*a*. Family Naticidae. *Roy. Soc. S. Aust. Malac. Sect.* Publ. 5.

————————., 1954*b*. Mollusca of the Outer Harbour. *Rec. S. Aust. Mus.* 11 (2): 165-176.

————————., 1956*a*. Family Thaididae. *Malac. Club of Vict.* Publ. 1.

——— ———., 1956*b*. Family Littorinidae. *Malac. Club of Vict.* Publ. 2.
———., 1957. "South Australian shells." *S. Aust. Mus.* Adelaide.
COTTON, B. C., and GODFREY, F. K., 1938. "Molluscs of South Australia. Part 1. Pelecypoda," Govt. Printer, Adelaide.
———., 1938*a*. Systematic list of the Gastropoda, etc., of South Australia. *Malac. Soc. of S. Aust.* Publ. 1.
———., 1940. "Molluscs of South Australia. Part II. Scaphapoda, Cephelopoda, Aplacaphora, Crepipoda." Govt. Printer, Adelaide.
CRIBB, A. B., 1954. The algal vegetation of Port Arthur, Tasmania. *Pap. Proc. Roy. Soc. Tasm.* 88: 1-44.
CROCKER, R. L., and COTTON, B. C., 1946. Some raised beaches of the lower south-east of South Australia and their significance. *Trans. Roy. Soc. S. Aust.* 70 (2): 64-82.
DAKIN, W. J., BENNETT, I., and POPE, E. C., 1952. A study of certain aspects of the ecology of the intertidal zone of the New South Wales coast. *Aust. J. Sci. Res.* (Ser. B.) 1 (2): 176-230.
DANNEVIG, H. C., 1915. Bass Strait. *Endeavour Reports* 3 (6): 347-353.
ENDEAN, R., KENNY, R., and STEPHENSON, W., 1956. The ecology and distribution of intertidal organisms on rocky shores of the Queensland mainland. *Aust. J. Mar. Freshw. Res.* 7 (1): 88-146.
EDMONDS, S. J., 1948. The commoner species of animals and their distribution on an intertidal platform at Pennington Bay, Kangaroo Island, South Australia. *Trans. Roy. Soc. S. Aust.* 72 (1): 167-177.
GENTILLI, J., 1948 Two climatic systems applied to Australia. *Aust. J. Sci.* 11 (1): 13-16.
———., 1948*a*. Tasmanian climate. Map in Regional Planning Atlas. Hobart.
GUILER, E. R., 1950. The intertidal ecology of Tasmania. *Pap. Proc. Roy. Soc. Tasm.* 1949: 135-201.
———., 1951*a*. The intertidal ecology of Pipe Clay Lagoon. *Pap. Proc. Roy. Soc. Tasm.* 1950: 29-52.
———., 1951*b*. Notes on the intertidal ecology of the Freycinet Peninsula. *Pap. Proc. Roy. Soc. Tasm.* 1950: 53-70.
———., 1952*a*. The ecological features of certain sheltered intertidal areas in Tasmania. *Pap. Proc. Roy. Soc. Tasm.* 86: 1-11.
———., 1952*b*. The intertidal ecology of the Eagle Hawk Neck Area. *Pap. Proc. Roy. Soc. Tasm.*, 86: 13-29.
———., 1952*c*. The nature of intertidal zonation in Tasmania. *Pap. Proc. Roy. Soc. Tasm.*, 86: 31-61.
———., 1953. Intertidal classification in Tasmania. *J. Ecol.* 41 (2): 381-384.
———., 1953*a*. Further observations on the intertidal ecology of the Freycinet Peninsula. *Pap. Proc. Roy. Soc. Tasm.*, 87: 93-95.

————————., 1954*a*. The recolonization of rock surfaces and the problem of succession. *Pap. Proc. Roy. Soc. Tasm.*, 88: 49-66.
————————., 1954*b*. The intertidal zonation at two places in Southern Tasmania. *Pap. Proc. Roy. Soc. Tasm.*, 88: 105-118.
————————., 1955. Australian intertidal belt forming species in Tasmania. *J. Ecol.* 43 (1): 138-148.
HEDLEY, C., 1904. The effect of the Bassian Isthmus on the existing marine fauna. A Study of ancient geography. *Proc. Linn. Soc. N.S.W.* 28: 876-883.
————., 1915. An ecological sketch of the Sydney beaches. (Pres. Address.) *J. Roy. Soc. N.S.W.*, 49: 15-77.
HUBENDICK, B., 1946. Systematic monograph of the Patelliformia K. *Svenska Vetenskapsakad. Handl.* 23 (5): 1-93.
————————., 1955. On a small quantity of siphonaria material from Queensland. *Mem. Nat. Mus. Vict.*, 19: 1-11.
IREDALE, T., 1924. Results from Roy Bell's molluscan collections. *Proc. Linn. Soc. N.S.W.*, 49 (3): 179-278.
————., 1937. A basic list of the land mollusca of Australia. *Aust. Zool.*, 8 (4): 287-335.
————., 1940. Marine mollusca from Lord Howe Island, Norfolk Island, Australia, and New Caledonia. *Aust. Zool.* 9 (4): 429-443.
————., and HULL, A. F. B., 1927. A monograph of Australian Loricates. *Roy. Zool. Soc. N.S.W.* Sydney, 1-168.
————., and MAY, W. L., 1916. Misnamed Tasmanian chitons. *Proc. Malac. Soc. Lond.*, 12: 94-117.
JOHNSTON, T. H., and MAWSON, PATRICIA M., 1946. A zoological survey of the Adelaide beaches. *Handbook of S. Aust.* (A.N.Z.A.A.S. 25th meeting), Adelaide Govt. Printer.
KERSHAW, R. C., 1955. A systematic list of the mollusca of Tasmania, Australia. *Pap. Roy. Soc. Tasm.* 89: 289-355.
————————., 1955*a*. Geological observations on the West Tamar. *Vict. Nat.*, 71 (9): 138-144; (10): 153-156; (11): 175-179.
————————., 1957. Notes on the intertidal fauna of the West Head, Nth. Tasmania. *Vict. Nat.*, 73 (9): 137-141.
LASERON, C. F., 1956. New South Wales Mussels. *Aust. Zool.*, 12 (3): 263-283.
————————., 1956*a*. A revision of the New South Wales Leptonidae. *Rec. Aust. Mus.*, 24 (2): 7-21.
MACPHERSON, J. HOPE, 1955. Preliminary revision of the families Patellidae and Acmaeidae in Australia. *Proc. Roy. Soc. Vic.*, 67 (2): 229-256.
———————— and CHAPPLE, E. H., 1951. A Systematic list of the marine and estaurine mollusca of Victoria. *Mem. Nat. Mus. Vict.*, 17: 107-185.
MAY, W. L., 1923. An illustrated index of Tasmanian shells. Govt. Printer, Hobart.
McALPIN, D., 1952. Notes on some Siphonariidae. *Proc. Roy. Zool. Soc. N.S.W.*, for 1951-52: 40-42.
NYE, P. B., and BLAKE, T., 1938. The geology and mineral resources of Tasmania. *Geol. Survey Report No. 8.*

POPE, E. C., 1943. Animal and plant communities of the coastal rock-platform at Long Reef, N.S.W. *Proc. Linn. Soc. N.S.W.* 68 (5-6): 221-254.

SCOTT, P., 1956. Variability of annual rainfall in Tasmania. *Pap. Proc. Roy. Soc. Tasm.*, 90: 49-57.

SMITH, T. H., and IREDALE, T., 1924. Evidence of a negative movement of the strand-line of 400 feet in New South Wales. *J. Roy. Soc. N.S.W.*, 58: 157-168.

TWEEDIE, M. W. F., 1942. The Grapsid and Ocypodid crabs of Tasmania. *Pap. Proc. Roy. Soc. Tasm.* for 1941: 13-25.

WOMERSLEY, H. B. S., and EDMONDS, S. J., 1952. Marine coastal zonation in southern Australia in relation to a general scheme of classification. *J. Ecol.* 40 (1): 84-90.

WEATHER BUREAU, 1936. Results of rainfall observations made in Tasmania. Melbourne.

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no. 3. 1959

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Miss Allan, Patron of the Society since 1956, is a recognized authority on mollusca; was the well-known Curator of Shells at the Australian Museum, Sydney, until 1956. She is the author of a great number of specialized conchological papers, including those in the *Australian Encyclopedia* (1958). Miss Allan is also known as the author of *Australian Shells, Cowry Shells of World Seas,* and recently, joint author with Gilbert Whitley in *The Sea Horse and Its Relatives.* She attended the International Congress of Zoology held in Copenhagen as Australian Representative, and also that of the Nomenclature Council. Miss Allan was the first woman to be given an F.R.Z.S. for her services to science.

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Patron of the Society for the past two years. Professor Abbott occupies the Pilsbry Chair of Malacology established in 1954 at the Academy of Natural Sciences in Philadelphia. His book on *American Sea-shells,* published in 1954, was followed by a smaller work in 1955, *Introducing Sea-shells.* He is a co-editor of the periodical *Nautilus,* and is editor-in-chief of *Indo-Pacific Mollusca,* a new series of taxonomic monographs of the marine mollusca of the Indo-Pacific which has just commenced publication.

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OBITUARY

CHARLES FRANCIS LASERON

Mr. Charles Laseron, who died in Sydney on 27th June, 1959, has during recent years made many notable contributions to Australian malacology. His early life was a most varied one, and included a trip to the Antarctic with Mawson's 1911-1914 expedition, many years of work as collector for the Technological Museum in Sydney, and service in two world wars, including the Gallipoli landing, as well as an intense interest in collecting shells.

Towards the close of his working life, he took up the scientific study of the marine molluscs in his collection, and soon found an enormous field for original research on the minute species which had been largely neglected by earlier workers. Starting with the New South Wales Marginellidae and Rissoidae in 1948 and 1950, he worked group by group through the smaller shells, later on expanding his studies to the Queensland and Northern Australian forms. His papers were always illustrated with his own drawings, which at first were simple, though adequate, and later reached an excellence which has seldom been equalled for small molluscs.

Some workers might not have agreed entirely with his systematics, but none would doubt the intense and absorbing interest which he found in these tiny shells and the endless hours of patient observation which went into the sorting, description and drawing of the many species with which he dealt. Laseron's work will stand for years as a basic reference for all who seek to identify the minute mollusca of eastern Australia.

Donald F. McMichael, Ph.D., Curator of Molluscs,
The Australian Museum.

TWO NEW GENERA OF LAND MOLLUSCS (PAPUININAE) FROM THE CENTRAL HIGHLANDS OF NEW GUINEA

By W. J. CLENCH, Ph.D.,* and R. D. TURNER, Ph.D.†

(Plate 1, Text fig. 1-3.)

We are grateful to Dr. D. F. McMichael of the Australian Museum, Sydney, for specimens of the species described below, one of which is new. Both species were obtained near the head of the Wahgi Valley, not far from the base of Mt. Hagen. These were collected in 1946 by F. S. Mayer. Dr. E. O. Wilson of the Biological Laboratories, Harvard University, collected *Papuanella ogeramuensis* (Kobelt) and *P. finisterrensis* (Kobelt) during his trip to the Huon Peninsula in 1955.

WAHGIA gen nov.

Shells depressed, trochoid in shape with the body whorl descending rapidly to form the aperture which is directed downward but not constricted. Aperture sub-elliptical with the peripheral area extended to form a "beak" and having a slight indication of a papuinoid notch. Whorls carinate.

In the reproductive system, the spermatheca is globular and has a very short spermathecal duct. The penis is short and has a small epiphallus with the vas deferens coming from the side and the penial retractor muscle attached to the penis at the base of the epiphallus.

Type species, *Wahgia juliae* Clench and Turner.

WAHGIA JULIÆ sp. nov.

(Plate 1, fig. 1-3; text fig. 1; text fig. 2, fig. 2-3.)

Description. Shell sub-depressed, trochiform, imperforate, nearly smooth, and reaching 34 mm. (about 1⅜ inches) in greatest diameter. Ground colour olive-brown, increasing in intensity toward the lip. On some specimens the black is diffused into the olive-brown near the aperture. On most specimens there is a narrow spiral band of black just above the acute keel. Whorls 4½ and acutely keeled, somewhat flattened above and convex below. Spire sub-depressed, obtuse and produced at an angle of about 100°. Aperture descending, sub-elliptical, rostrate, with a well-defined notch and produced at an angle of about 25° from the base. Outer lip rather narrow, straight above the keel and reflected below. Columella very short. Suture very slightly indented.

Height	Width	
21 mm.	32 mm.	Holotype
20.5	33	Paratype
21.5	34.5	Paratype
18.5	27.5	Paratype
18	28	Paratype

Types. The holotype of *Wahgia juliae* is in the Australian Museum, Sydney, Australia, no. C.62212. The type locality is twelve miles N.E. of Mount Hagen Range, Sepik-Wahgi Divide, New Guinea, at 5000-6000 feet, F. S. Mayer collector, November 1946. Paratypes from the same

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locality are in the Australian Museum no. C.62213 and the Museum of Comparative Zoology no. 191399 and 191400.

Remarks. This is a very distinctive species and we know of nothing to which it is closely related. It appears to be nearest in both shell morphology and type of colouration to *Pompalabia macgillivrayi* (Forbes) of northern Queensland, but the reproductive systems are quite different. The spermatheca in *juliae* is globular with a very short spermathecal duct, while in *macgillivrayi* the spermatheca is oval and the stalk is sixteen times as long as the spermatheca. The penial apparatus in *juliae* is short and is without a flagellum; in *macgillivrayi* it is long and has a flagellum. This new species has a superficial resemblance to *Rhynchotrochus,* differing mainly in its type of colouration but again very different in its soft anatomy. The penis of *Rhynchotrochus tayloriana* (Adams and Reeve) is elongate and has a long, narrow epiphallus with the vas deferens and a small flagellum at the end. In *juliae,* the epiphallus is very short and thickened, with the vas deferens coming from the side, and no flagellum.

Specimens examined. NEW GUINEA: Twelve miles north-east of Mt. Hagen, Sepik-Wahgi Divide at 5000-6000 feet; hills south of Baiyer River, about 20 miles north of Mt. Hagen (AM; MCZ).

PAPUANELLA gen. nov.

Shells trochoid in shape with the body whorl of the adult descending slightly to form the aperture which is directed downward and is somewhat contracted. Aperture subcircular to ovate. The lip is simple, slightly thickened but not reflected, and lacking a papuinoid notch. Whorls convex and slightly carinate.

The reproductive anatomy is characterized by a ovate spermatheca with a moderately long spermathecal duct. The penial apparatus is short and has a moderately thick wall with a short and recurved epiphallus. The penial retractor muscle is attached to the epiphallus at the recurved area. In general shell outline this genus is shaped similarly to *Noctepuna* of Queensland, but the reproductive systems of these two groups are very different, and in shell characters they differ in that the aperture of *Noctepuna* is not constricted.

Type species, *Geotrochus ogeramuensis* Kobelt.

PAPUANELLA OGERAMUENSIS (Kobelt).

(Plate 1, fig. 4-7, text fig 2, fig. 1, 4; text fig. 3.)

Geotrochus ogeramuensis Kobelt 1914, *Nachrichtsblatt Malak. Gesell,* 46, p. 5; *ibid* 1917, 49, p. 5, pl. 1, fig. 4. (Ogeramua [Finisterre Mts.] German New Guinea).

Description. Shell extended, trochiform, imperforate, nearly smooth, glossy and reaching 25 mm. (about 1 inch) in greatest diameter. Ground colour yellowish to light yellowish green with a few specimens being a reddish brown. Occasional specimens may be a uniform greenish yellow, though there is generally one, and sometimes up to five, spiral bands of colour which range from brown to nearly black. The body whorl is usually predominantly green. Earliest 2½ whorls dark brown to black. The umbilical area and the inner surface of the lip black to bluish black. Interior of the aperture bluish black. Whorls 5 and moderately

convex with the periphery of the body whorl faintly keeled. Spire extended, acute and produced at an angle of about 65°. Aperture subcircular to ovate, slightly descending and cast at an angle of about 27° from the base. Outer lip simple, straight and without a papuinoid notch. Parietal wall thinly glazed. Columella short, slightly curved and dark brown edged with gray. Sculpture consisting of very numerous and fine diagonal growth lines, nuclear whorls smooth.

Height	Width	
24.5 mm.	25.5 mm.	15 miles N.E. of Mt. Hagen.
23	24	15 miles N.E. of Mt. Hagen.
21.5	22	15 miles N.E. of Mt. Hagen.
21	20.2	15 miles N.E. of Mt. Hagen.

Types. According to Sherborn (1940) the Kobelt collection is in the museum at Frankfurt a/M. The type locality is Ogeramua, Finisterre Mountains, German New Guinea.

Remarks. This is a very variable species, particularly in colour, ranging as it does from a uniform light greenish yellow to specimens which are nearly uniform dark blackish brown. The dominant colour pattern, however, is a yellowish green with a peripheral band of blackish brown.

The reproductive system of *P. ogeramuensis* is characterized by its short, thick-walled penis which has a short, recurved epiphallus with the vas deferens coming from the side near the end. The spermatheca is ovate and the spermathecal duct is about one-third the length of the uterus. *Papuanella finisterrensis* (Kobelt) has a very similar reproductive system.

Range: The range of the species, so far as now known, extends from Telefomin, east-south-east to the Huon Peninsula, a distance of about 450 miles.

Specimens examined: NEW GUINEA: Aiyura, 80 mi. N.W. of Lae at 6000 ft.; Minj, 55 mi. W. of Goroka; 15 mi. N.E. of Mt. Hagen Range at the Sepik-Wahgi Divide at 5000-6000 ft.; hills south of Baiyer River about 20 mi. N. of Mount Hagen; 2 mi. S. of Telefomin, Victor Emanuel Range (all AM; MCZ); Gemeheng, Hube area and Tumnang, Mangi Watershed, both Huon Peninsula (both MCZ).

PLATE I.

Fig. 1-3, *Wahgia juliae* Clench and Turner, 12 mi. N.E. of Mt. Hagen, Sepik-Wahgi Divide, New Guinea. Fig 1. Holotype, Australian Museum no. C.62212.

Fig. 2. Paratype, Museum of Comparative Zoology no. 191399.

Fig. 3, Paratype, Museum of Comparative Zoology no. 191400 (all 1.6x).

Fig. 4-7. *Papuanella ogeramuensis* (Kobelt), 15 mi. N.E. of Mt. Hagen, Sepik-Wahgi Divide, New Guinea.

Fig. 4-6. Australian Museum no. C.62214.

Fig. 7. Museum of Comparative Zoology no. 191399 (all 2x).

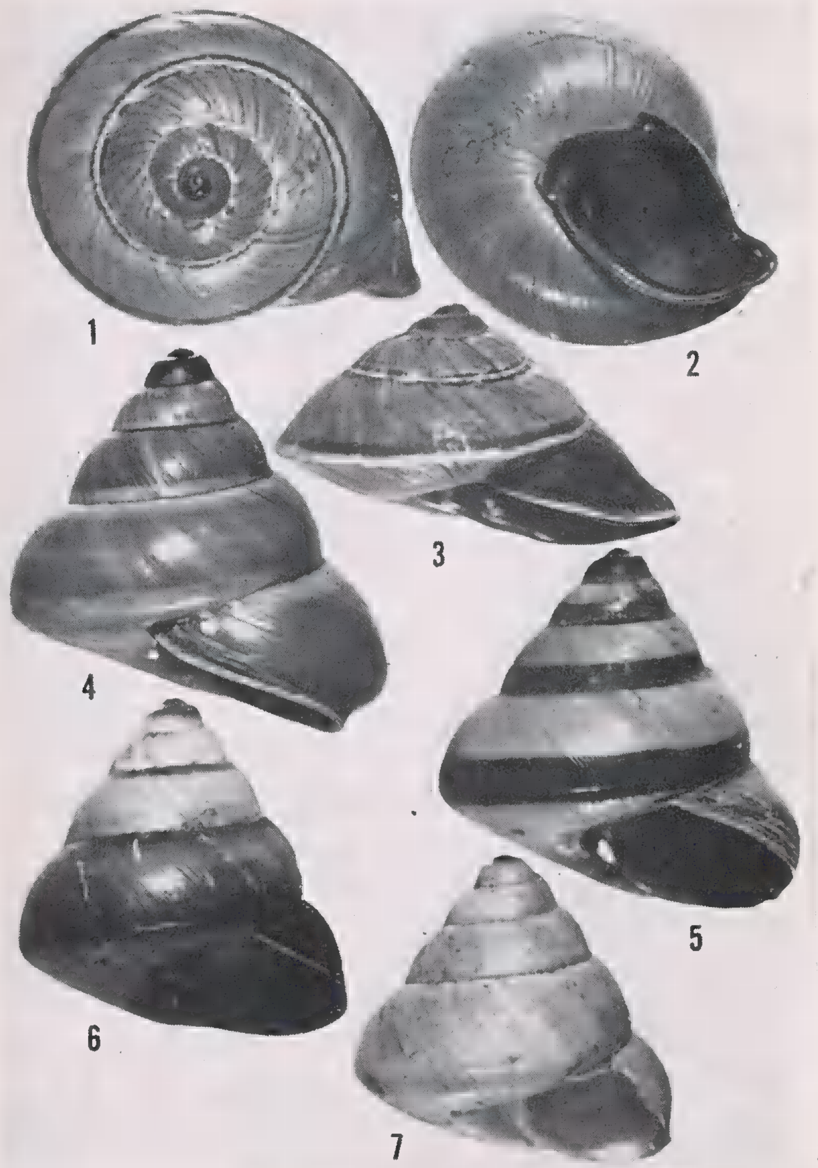
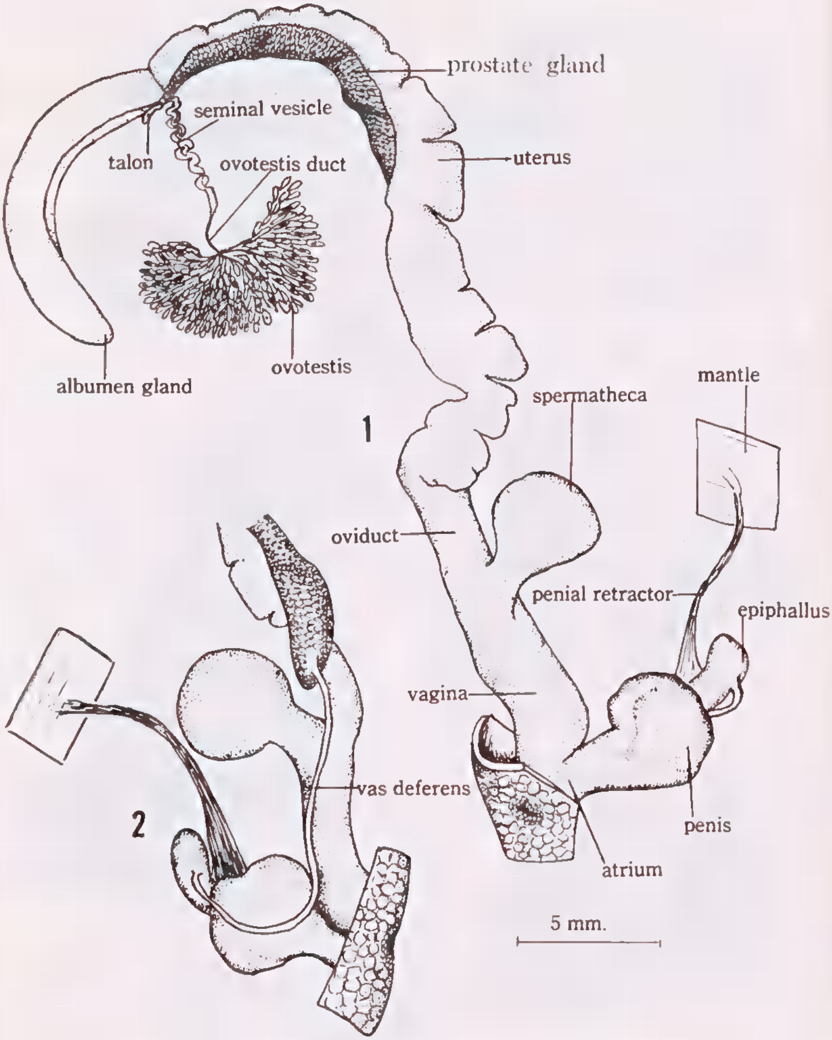
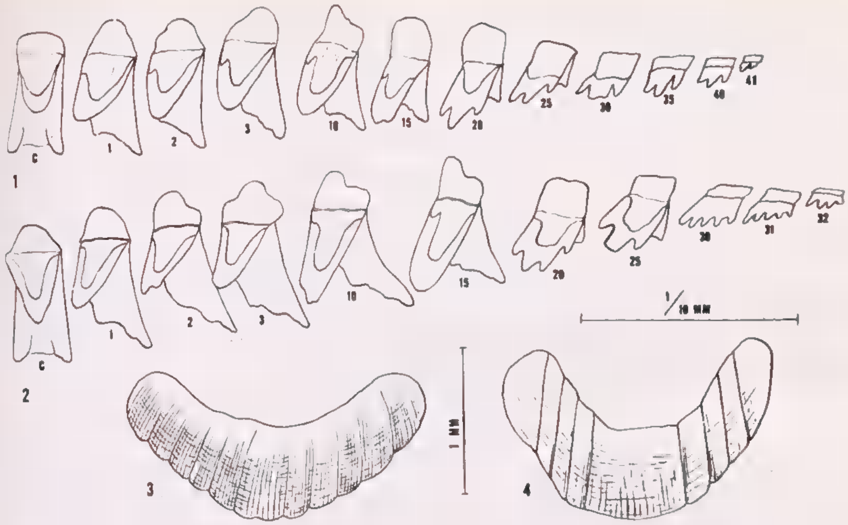


PLATE I.



Text fig. 1.

Reproductive anatomy of *Wahgia juliae* Clench and Turner.
Fig. 1. Complete system.
Fig. 2. Basal area reversed.



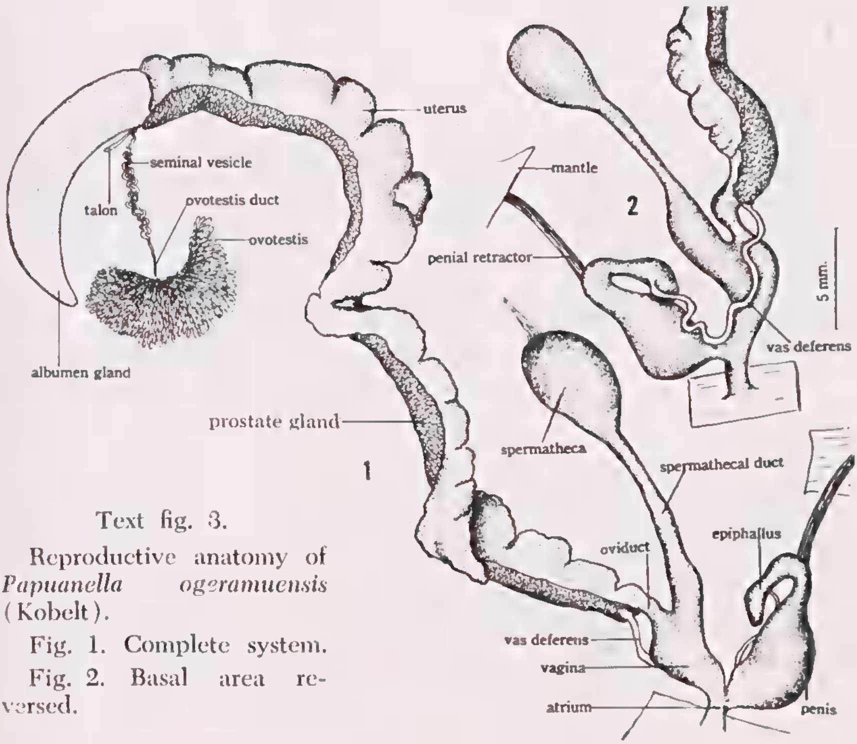
Text fig. 2.

Fig. 1. Radula of *Papuanella ogeramuensis* (Kobelt).

Fig. 2. Radula of *Wahgia juliae* Clench and Turner.

Fig. 3. Jaw of *Wahgia juliae* Clench and Turner.

Fig. 4. Jaw of *Papuanella ogeramuensis* (Kobelt).



Text fig. 3.

Reproductive anatomy of *Papuanella ogeramuensis* (Kobelt).

Fig. 1. Complete system.

Fig. 2. Basal area reversed.

CHANGES IN SHAPE WITH TIME IN AUSTRALIAN SPECIES OF *AUCELLINA* POMPECKJ (AVICULOPECTINIDAE)

By RUDOLF O. BRUNNSCHWEILER, Ph.D.*

(Text Fig. 1-7.)

ABSTRACT.

Progressive changes in shape and size with time of right valves of a series of forms of *Aucellina* Pompeckj, the best known of which is *Aucellina hughendenensis* (Etheridge sen.), are demonstrated. The presumably genetically controlled variations took place during upper Albian times, i.e., during the time of deposition of what is known as the Tambo Formation of the Great Australian Artesian Basin. Systematic position and phylogeny of Aucellininae *nov.* are discussed.

INTRODUCTION.

The individual elements of the marine faunas contained in the Lower and Middle Cretaceous formations of the Great Australian Artesian Basin are fairly well known from numerous publications by pioneers of Australian Mesozoic palaeontology such as W. B. Clarke, R. Etheridge sen., R. Etheridge jun., W. H. Hudleston, F. McCoy, C. Moore, J. E. T. Woods, F. W. Whitehouse, and some others. A very important aspect of the biostratigraphy of the eastern Australian Cretaceous, however, is still in its infancy. It is the establishment and delimitation of local faunizones, their correlation with each other, and their relation with standard zones overseas.

The first serious attempt to subdivide the Cretaceous System of the Artesian Basin according to faunizone concepts was made by Whitehouse (1926a, 1926b, 1927, 1928). Through an admirable analysis of all then known ammonites he established which of the standard zones of the Aptian and Albian Stages are likely to be represented in the Artesian Basin formations provided always, of course, that the succession of species responsible for the European standard time-scale can be assumed to repeat itself in the form of more or less closely related, analogous, form series in Australia.

Broadly speaking, the assumption of such repetition is part of the fundamental working hypothesis applied to palaeontological-stratigraphical correlation problems. However, the early and rather uncritical enthusiasm for this hypothesis has in the last two or three decades been somewhat dampened. While it still holds good in principle, it has also become evident that the concept had been driven too far when it was assumed that any, even the smallest, subdivision of a faunizonal time-scale was a world-wide recognizable thing.

Whitehouse (*loci cit.*) was working under a significant handicap. Although he described and analysed a great number of ammonites from various collections, he had little or no exact information on and could therefore not vouch for their relative position within the formations whence they came from. He was able to show, e.g., that genera and species, which, in Europe, are found together in a certain zone, have

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their phenotypical counterparts in a formation of the Artesian Basin sequence. Yet there does not *eo ipso* follow that the Australian forms are contemporaneous in the same way as are their European cousins. In the absence of direct field evidence Whitehouse simply had to assume that this is so. This may well be correct, of course, but to this date Whitehouse's zonal subdivision of the eastern Australian Cretaceous has not been factually substantiated and remains a working hypothesis the applicability of which must still be demonstrated.

This paper is a small step in a similar, or parallel, direction. By the example of *Aucellina* is shown what interesting results may be obtained from the study of faunas encountered in continuous bore cores. Thousands of bores have, of course, been drilled in the Artesian Basin in order to tap the vast water resources it contains. Unfortunately, the great majority of these bores were sunk with percussion (cable) tools. There are consequently scarcely any worthwhile records of macrofossils in the respective logs. Even from the limited number of bores in which cores were taken one knows preciously little about the sequence of fossils in the formations that have been penetrated.

The continuously cored bore which yielded the hereafter described series of *Aucellina* forms was drilled in 1957 by an oil company a few miles north-west of Oodnadatta, in northern South Australia, i.e., in the western marginal region of the Great Artesian Basin. To my knowledge it is the first continuous bore section whose succession of marine Cretaceous faunas has been recorded in detail while drilling was in progress. Not unexpectedly, I found a number of characteristic genera and species to be restricted to certain levels within the formations, but this short paper is not the place in which to enlarge on these interesting and important observations which have opened promising new avenues for more accurate and useful local zoning of the Cretaceous System in Eastern Australia.

For the present state of our knowledge on the stratigraphy and structure of the Great Artesian Basin the reader is referred to the up-to-date summaries by Sprigg (1958), Sprigg and Staff (1958), Whitehouse (1954), and David (1950). In Sprigg and Staff (1958) a summary log of the Oodnadatta bore (fig. 19a, p. 92) and an account of the recent stratigraphical observations (pp. 94-97, Rolling Downs Group) is given. Our *Aucellina* form series is from the "richly fossiliferous mudstone (Tambo Formation)" which comprises the top 425 ft. of the bore section. The individual members of the form series were found at the following levels:

Table 1.

Ranges of *Aucellina* Species in Bore near Oodnadatta.

Form F (youngest) was found on surface, probably in beds which are slightly younger than the beds of the top part of the bore section.

Form E, approximately from depth 100 ft. to 0 ft.
Form D, approximately from depth 235 ft. to 220 ft.
Form C, approximately from depth 300 ft. to 240 ft.
Form B, approximately from depth 345 ft. to 250 ft.
Form A, approximately from depth 375 ft. to 330 ft. (oldest).

All specimens described hereafter are deposited in the palaeontological reference collection of the consulting firm Geosurveys of Australia Ltd., Grenfell Street, Adelaide.

ON THE SYSTEMATIC POSITION OF *AUCELLINA* POMPECKJ.

The genus *Aucellina* was introduced by Pompeckj (1901) in order to accommodate a number of Middle Cretaceous (Aptian to Cenomanian) *Aucella*-like lamellibranchs which are known from various parts of the world. Of the two typical species named by Pompeckj *Aucellina gryphaeoides* (Sowerby) was subsequently designated as genotype by Marwick (1939).

The question of the systematic position of the genera *Aucella* Keyserling[1] and *Aucellina* has been the cause of much discussion among taxonomists. An exhaustive analysis is found in Pompeckj (1901). Although he did not really solve the problem his meticulous description and comparisons of the morphological features and those of related genera came to be the foundation of all later discussions. It seems the problem has recently been solved for good. Ichikawa (1958) demonstrates convincingly that *Aucella* and *Aucellina* belong to the family Aviculopectinidae (Etheridge jun., 1906) em. Newell, 1938, in which he has grouped them as subfamily Aucellinae (Fischer, 1887) em. Ichikawa, 1958, along with Oxytominae Ichikawa, 1958; Aviculopectininae Newell, 1938, and Pseudomonotinae Newell, 1938.

Whether *Aucellina* and *Aucella* should be regarded as members of the same subfamily may be of secondary importance, but nevertheless questionable. As Pompeckj (1901) has clearly shown, they are not as closely related as their superficial similarity in outline and other characters suggest. Their hinge features are evidently not the same. In *Aucella* there is a rather high degree of what may be called specialization when compared with the hinge features in the ancestral lineage which, as Ichikawa (1958) suggests—as did Pompeckj—includes *Pseudomonotis* Beyrich, 1862, and *Meleagrinella*, Whitfield, 1902. *Aucellina*, on the other hand, has hinge characters which are in every respect closer to the ancestral *Meleagrinella* (= *Pseudomonotis* in Pompeckj, 1901) pattern than to that of *Aucella*. The latter is not likely to have been the forerunner of *Aucellina* except, of course, in the sense that the aucellid phenotype had evolved from meleagrinellid stock once before, i.e., in Upper Jurassic times. By the end of the Neocomian this specialized lineage had, however, died out, and *Aucellina* evolved during the Aptian independently, again showing clearly the ancestral hinge characters of *Meleagrinella*, i.e., characters which all later species of *Aucella* had largely lost. There is no evidence of intermediate forms which would link the specialized late forms of *Aucella* with the earliest representatives of *Aucellina*. Pompeckj (1901) has demonstrated this point, and since then nothing has been discovered that would contradict his findings. On the other hand, since the genus *Meleagrinella*—which has its earliest representatives in the Rhetian (Ichikawa 1958)—persists together with *Oxytoma* Meek, 1864, into the Upper Cretaceous, *Aucellina* could easily have been an offshoot in the Lower Cretaceous from that stock, as was *Aucella* at the beginning of the Upper Jurassic.

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[1]As regards the case *Aucella* versus *Buchia* Rouillier, 1845, see Jeletzky (1955).

The *Aucellina* lineage thus forms a phylogenetic group of equal rank as does the *Aucella* series or, for that matter, the predominantly Australian series of *Maccoyella* Etheridge jun., 1892, which stems also from aviculopectinid stock and arose at about the same time as did *Aucellina*. Phylogenetically this should be expressed by accommodating *Aucella* and *Aucellina* in separate subfamilies, i.e., Aucellinae (Fischer, 1887) em. Ichikawa 1958, and Aucellininae *nov.* of the Aviculopectinidae.

THE AUSTRALIAN REPRESENTATIVES OF *AUCELLINA*.

Species of *Aucellina* are among the commonest forms in eastern and northern Australian Albian formations. Because of the sessile and gregarious habits of the genus, one finds in places bands of real *Aucellina*—coquinites. The earliest Australian record is found in Etheridge sen. (1872) under the name *Avicula hughendenensis*. Etheridge jun. (1884) transferred this species to *Aucella*, and Pompeckj (1901) finally to *Aucellina*.

Pompeckj (1901) records, apart from *A. hughendenensis*, also *A. gryphaeoides* (Sowerby) from the Albian of Queensland. The species from the uppermost Albian near Darwin (Whitehouse, 1926b) received the name *A. incurva* by Etheridge jun. (1902). All three forms are similar morphologically, but they cannot be taken as variations of the one species, e.g., of *A. gryphaeoides*, as has been suggested to me verbally by colleagues. *A. incurva* is, on closer inspection, quite distinct from *A. gryphaeoides*. The latter's left valve has a far less prominent umbo, and its right valve shows not only a relatively larger anterior ear and a correspondingly narrower byssus slit, but also a fairly large posterior ear (or wing), a feature that is almost non-existent on *A. incurva*. Excellent figures of *A. gryphaeoides* are given in Woods (1905, pl. 10, figs 6-13).

Actually, the right valve of *A. incurva* is more like that of *A. aptiensis* (d'Orbigny), i.e., more or less obliquely circular (see Pompeckj, 1901, pl. 16, figs. 1-4). But these two species differ decidedly in the form of the left valve.

Closest to *A. gryphaeoides* is evidently Etheridge's *A. hughendenensis*. The only difference between these two lies in the latter's distinct radial riblets and striae on the left valve (in addition to the concentric ornament) and the typically more elongate, fan-like, obliquity of its right valve. On *A. gryphaeoides* radial ornamental elements are only rarely noticeable, and then on right valves and only very faintly. The ornament of *A. hughendenensis* recalls more that of *A. sancta-quirini* Pompeckj, but the latter's left valve has a slenderer and higher umbo and is in general outline more elongate oblique and slender, i.e., similar to *A. incurva*.

Consequently, it is better to keep the mentioned Australian species separate from each other and from overseas representatives of *Aucellina*, at least at the present stage of our knowledge of these forms. As will be seen presently, there is a fair measure of justification for such a cautious approach because the analysis of the *Aucellina* series from Oodnadatta suggests strongly that these and other forms are representing stages in a phylogenetic lineage. They are not geographical variations or subspecies, not "Standortsrassen" (local races of a species). These stages evolved through long times (several millions of years); when stage 3, for example, had been reached there were evidently no survivors left of stage 1. None of stage 2 were left when stages 4 or 5 were flourishing, and so on.

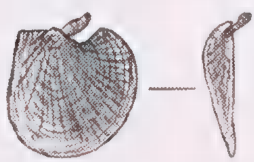
Wright (1958) has recently again emphasized the point of view of the palaeontologist as regards the concept of "species." The current definition of species as "a potentially interbreeding population" is rather wide open to criticism in its application to classification. It is a neontologist's concept which ignores the element of time. In the case of the *Aucellina* series, as in many other cases, we have no means of testing whether the early and late stages could interbreed. Placing all known Australian forms into one and the same species would, however, imply just that. This is surely a much too venturesome assumption. Consequently, as long as the evolutionary stages are in some or other way recognizeable and separable morphologically they should be treated as distinct species. In the following demonstration of an *Aucellina* series this principle is adhered to, although—because of the still rather small number of specimens available—a *nomenclatura aperta* is applied.

THE *AUCELLINA* SERIES FROM OODNADATTA.

Six morphologically distinguishable types of right valves are now known from the Albian of northern South Australia. Left valves show, apart from size, scarcely any differences. If there are some, they have probably been obliterated by the effects of rock diagenesis. *Aucellina*, unlike many species of *Aucella*, is very thin-shelled and fragile. Left valves especially, being much more inflated than right valves, are always found crushed with their delicately twisted umbo flattened and the hinge characters distorted. The primarily flattish right valves, however, are commonly perfectly preserved and can be studied in every detail. They are shown in text fig. 1-6 along with the necessary descriptions.

AUCELLINA sp. nov. A. aff. *A. APTIENSIS* (d'Orbigny).

Text fig. 1, (x 1½).



Aucellina sp.nov. A. aff. *A. aptiensis* (d'Orbigny).
Right valve, side and frontal aspects.

Description: A small species of the series. This right valve is moderately inflated, with rather distinct, slightly opisthocline (see Newell, 1938) umbo. Height and length are equal. Both anterior and ventral margins are evenly rounded. Posterior margin straight, forming an angle of between 90° and 100° with the cardinal margin, thereby enclosing an almost recto-triangular, clearly individualized, posterior ear (or area).

The anterior ear (or byssus ear) is long and slender. It is turned upward at an angle of 20-25° to the cardinal margin, as well as inward, i.e., against the left valve. The byssus slit between it and the prominently produced antero-cardinal wing (or ear) is wide and deep, reaching almost beneath the umbo.

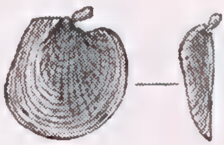
The ornament consists of both radial and concentric striae and riblets. The radial ornament weakens towards the ventral and the posterior margins. Only concentric striae remain there. Fine concentric lamellae are discernible also on the byssus ear.

Comparisons: This right valve does not match any of the species described in the literature. None of these shows the up-and-inward twisted byssus ear and the subrectangular postero-cardinal margin. In its other features, especially the opisthoclinal to aclinal umbo, *sp. nov.* A. recalls to some extent *Aucellina aptiensis.* This is perhaps not surprising because the Australian form is, like d'Orbigny's species, apparently the oldest of a phylogenetic series. It certainly differs very much from *A. hughendenensis.*

The figured specimen comes from a depth of 370 ft. 8 in. in the bore. The vertical range of the species is given in Table 1.

AUCELLINA sp. nov. B. cf. A. *GRYPHAEOIDES* (Sowerby).

Text fig 2, (x 1½).



Aucellina sp. nov. B cf. *A. gryphaeoides* (Sowerby).

Right valve, side and frontal aspects.

Description: A small species of the series. This right valve is moderately inflated, with rather distinct, acline to slightly prosocline umbo. Height and length are equal. Anterior and ventral margins evenly rounded. Posterior margin straight, forming an angle of 115-125° with the cardinal margin, thereby enclosing a clearly individualized posterior ear. The anterior or byssus ear is fairly long, but not as slender as in the other forms. It is turned upward at an angle of 10-20° to the cardinal margin, as well as slightly inward towards the left valve. The byssus slit is wide and deep, reaching beneath the umbo. The antero-cardinal wing is produced with a sharply curved margin. The ornament consists of both radial and concentric striae and riblets. The radial elements weaken towards the ventral and the posterior margins, where only concentric striae and weak folds remain. The concentric (transverse) lamellae on the byssus ear are very weak.

Comparisons: This form is very similar to *sp. nov.* A, but has a less up-and-inward twisted byssus ear, a greater postero-cardinal angle, a less dense radial ornament, and a nearly horizontally (instead of upward) opening byssus slit. Also, the antero-cardinal edge is less upward produced than in *sp. nov.* A. With its prosocline umbo and the consequent tendency to the typical aucellinid obliquity *sp. nov.* B begins to approach the phenotype of *Aucellina gryphaeoides* (see Woods, 1905, pl. 10, figs. 6c and 7b) although its postero-cardinal angle has not yet reached the obtusity of

the respective European species. In this it also differs from *A. hughendenensis,* whose elongate obliquity of the right valve is (as in *A. gryphaeoides*) much more pronounced.

The figured specimen comes from a depth of 298 ft. 6 in. in the bore. For the vertical range of the species see Table 1.

AUCELLINA sp. nov. C. cf. *A. HUGHENDENENSIS* (Etheridge sen.).

Text fig 3, (x 1½).

Aucellina sp. nov. C. cf. *A. hughendenensis* (Etheridge sen.).

Right valve, side and frontal aspects.

Description: A medium to fairly large sized species of the series. Right valve almost flat, with scarcely protruding acline to prosocline umbo. Length exceeding height by about 10%. Anterior and ventral margins evenly rounded. Posterior margin first continuing as evenly convex as the ventral margin but towards the cardinal margin developing a slightly concave re-entrant. The posterior ear is thereby well individualized. The postero-cardinal angle is typically well over 120°. In outline this species is therefore nearly circular with a long, straight, cardinal margin. The byssus ear is long and slender, forming a horizontal process that is not twisted against the left valve. The byssus slit is long and narrow, reaching to the small umbo. The antero-cardinal wing of the valve has a horizontal, straight, cardinal margin (almost as long and straight as the posterior cardinal margin), which curves gently into the anterior margin.

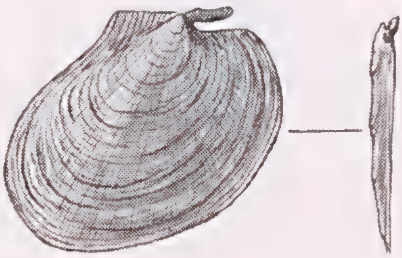
The ornament of concentric striae and weak folds is rather attenuated, and so are the fine lamellae on the byssus ear.

Comparisons: The flatness of the valve, the features of the cardinal margin, the slight concavity of the upper posterior margin, and the increased average size as well as the height/length ratio of this *sp. nov.* C quite definitely foreshadow *Aucellina hughendenensis.* Yet it is equally obvious that *sp. nov.* C has not quite "arrived" there. Its only slightly prosocline umbo and consequently little oblique, almost circular, outline still recalls the forerunners A and B *sp. nov.* C is also individualized by the complete absence of radial elements in its ornament of the right valve. This characteristic feature may actually mean that *A. hughendenensis* proper, with its typical radial ornament, is an independent offshoot from A or B, i.e., that *sp. nov.* C is not in its ancestral stock.

The figured specimen comes from a depth of 296′ 4″ in the bore, and the vertical range of the form is shown in Table 1.

AUCELLINA HUGHENDENENSIS (Etheridge sen.)[2]

Text fig. 4 (x 1½).



Aucellina hughendenensis (Etheridge sen.)

Right valve, side and frontal aspects.

2 = Form D on Table 1.

Description: This well-known species belongs to the largest that have been evolved within the genus. The right valve is almost flat, with a very small umbo which is moderately to strongly prosocline. Length exceeding height by over 10%. Anterior and ventral margins broadly and evenly rounded. Posterior margin evenly convex in lower part but fairly strongly concave before reaching the cardinal margin, thereby deliminating a rather long, obtusely triangular posterior ear. Postero-cardinal angle 130-140° or even more. In outline this species is therefore fairly elongate oblique with a moderately long, straight, cardinal margin (about half the length of the valve). Except for being shorter in relation to the length of the valve, the features of the cardinal region are almost identical with those in *sp. nov. C*. Because of a slenderer byssus ear, however, the byssus slit appears somewhat wider.

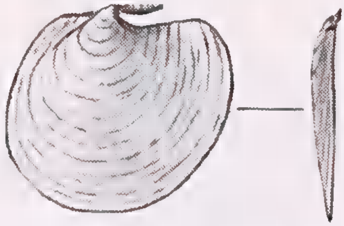
The ornament consists of both radial and concentric elements. There are dense radial striae and fairly broad, but low, concentric folds. The concentric striae are of about equal density as the radials except on the posterior, marginal portion of the valve, where only concentric elements remain. Byssus ear finely lamellate.

Comparisons: The affinities of *Aucellina hughendenensis* have been discussed in the introductory parts to this article. In our series it stands, morphologically speaking, between A/B on the one hand and C/E/F on the other, i.e., by uniting and carrying characteristic features of the two other groups it may be taken as "typifying" the whole series in its "temporal and geographical variation," and as far as Australia is concerned, in the sense of Wright (1958, p. 144, para. 2).

In itself, however, *A.hughendenensis* is probably a single offshoot from the main line (which was carried on through E and F to *A.incurva*, while *hughendenensis* died out before *incurva* appeared) that was very successful for a short time but left no descendants.

The typical *A.hughendenensis* as represented by text fig. 4 occupies only a small interval of Albian times. The figured specimen comes from a depth of 231′ in the bore. The apparently very short range of the species is shown on Table 1.

AUCELLINA sp. nov. E. cf. *A. INCURVA* (Etheridge jun.).
Text fig. 5, (x 1½).



Aucellina sp. nov. E. cf. *A. incurva* (Etheridge jun.).
Right valve, side and frontal aspects.

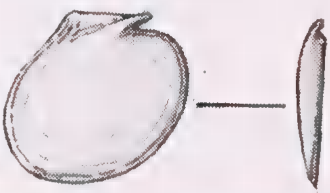
Description: This species is of moderate to large size. The right valve is only very slightly inflated. The only moderately prosocline umbo is small but well defined, sharply pointed, and protruding a little above the cardinal margin. Height of valve only slightly less than length. Posterior, ventral, and anterior margins evenly rounded. Antero-cardinal edge sharply rounded, almost angular. Posterior wing small and rounded, forming only a narrow, elongate area behind the umbo. Byssus ear slender, fairly long, horizontal. Byssal slit deep and narrow, reaching beneath the umbo. Anterior cardinal margin long, a little concave, about twice as long as the byssal ear. Anterior wing of valve prominently extended, relatively much larger than in any of the other forms. In outline this form is thus subcircular, but conspicuously inequilateral with the umbo set backward. The cardinal margin as a whole is long (about ⅔ the length) and slightly concave, without the typical en-échélon step-down under the umbo (in side view) of the other species. Byssus ear parallel to cardinal margin, not twisted towards left valve. Ornament of extremely fine concentric striae or none at all. Very fine lamellae on byssus ear.

Comparisons: This species clearly approaches *Aucellina incurva* especially in its enlarged anterior wing and the loss of the angularity of the postero-cardinal edge. However, because of its well-defined umbo and its subcircular rather than obliquely elongate outline it remains distinct from *A.incurva* (Etheridge jun., 1902, pl. 7, figs. 22, 24, 27).

The figured specimen comes from a depth of 73′ 5″ in the bore. The range of the species is shown on Table 1.

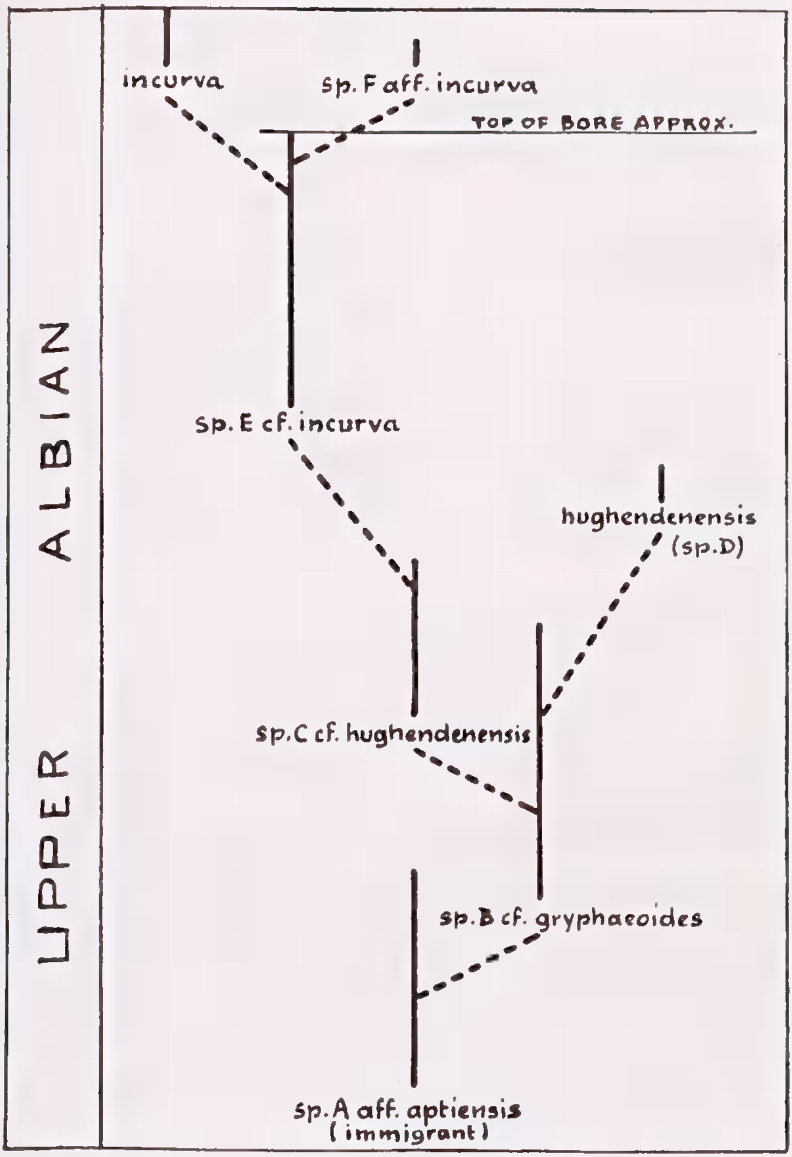
AUCELLINA, sp. nov. F aff. *A. INCURVA* (Etheridge jun.)

Text fig 6, (x 2).



Aucellina sp. nov. F. aff. A. *incurva* (Etheridge jun.).
Right valve, side view.

Description: This is a small species of the series. The right valve is flat or only slightly inflated. The poorly defined umbo is strongly



Text fig. 7.

PHYLOGENY OF AUSTRALIAN *AUCELLININAE.*

Note: Branching to the right means tendency towards phenotype of *Aucellina hughendenensis.*

Branching to the left means tendency towards phenotype of *Aucellina incurva*

prosocline. Height of valve only slightly less than length. Anterior and ventral margin broadly and evenly rounded, posterior margin straight or faintly concave towards cardinal margin, forming an obtuse angle (over 130°) with the latter and thereby enclosing an elongate, narrow, triangular posterior ear similar to that in *sp. nov.* C. Byssus ear short, more like a simple, sharp fold than a spoon-shaped process. Byssal slit rather short and narrow. Anterior wing of valve rather small with evenly, broadly rounded antero-cardinal end. Posterior portion of shell conspicuously larger than anterior, umbo set forward. In outline this form is therefore moderately elongate oblique. No ornament noticeable.

Comparisons: Since this form was found on the surface in a quite different state of preservation (limonite replacement) from those in the bore comparison is not easy. In general outline it resembles *Aucellina hughendenensis,* but the short and simple byssus ear and the absence of any ornament may indicate closer relationships to the species E and C, i.e. to the lineage which seems to end in *A.incurva.* The exact stratigraphical position of this form F is unfortunately not known, but it is certain that it is younger than species E not only because F was not encountered in the bore, but also because field evidence suggests that the gypsiferous beds which contain F are probably younger than the youngest beds in the bore. These circumstances prompt me to leave *sp. nov.* F. in the *incurva* group.

The figured specimen comes from the gypsiferous shales just north of the Arckaringa Road about fifteen miles south-west of Oodnadatta.

SUMMARY AND CONCLUSIONS.

The afore described six species of *Aucellina,* in this case all characterised by the features of their right valves under *nomenclatura aperta,* show that variations in shape and size with time are very considerable in this genus even within a comparatively short geological time interval such as the upper Albian. It is understood, of course, that additional drilling in the Artesian Basin may not only bring about some corrections to the range in time of the individual members of this *Aucellina* series, but may also produce a number of intermediate forms which may appear to close some of the as yet quite astounding "gaps" between our six species. Yet this cannot alter the fact that rapid phenotypic changes take place on what I consider to be the specific level. The discovery of some more *Aucellina* forms could possibly make the taxonomic classification of the members of this series more difficult because transitional forms might have to be accommodated. Yet this may not prove to be problematical.

It all depends at what time such "transitional forms" make their first appearance. A form which appears morphologically intermediate between e.g. our species A and B will spell taxonomic trouble for A and B only if its first appearance is before or, at the latest, at the same time as that of B, i.e., if the new form is transitional also in the temporal sense. If it appears after B, however, or even after C or D, it must be classified as a separate species. It is most likely a homoeomorph, a throw-back, further along the lineage, which means that it had no chance of interbreeding with the phenotypically similar ancestors—the latter were already extinct. The "transitional form" must stand on its own in such cases.

This is also, I presume, what Wright (1958) means by "phylogenetical thinking," and I cannot but agree with him. One understands why he repeatedly criticised neontologists for some of their classification efforts which did not allow for the element of time.

To conclude this paper on the Australian *Aucellina* series, the results are presented in text fig. 7 in the form, still tentative, of course, of a phylogenetic interpretation.

REFERENCES.

DAVID, T. W. E., and BROWNE, W. R., 1950–The Geology of the Commonwealth of Australia, London: Arnold.

ETHERIDGE, R., sen., 1872–Notes on the Geology of the Colony of Queensland. *Quart. J. geol. Soc. London,* 28.

ETHERIDGE, R., jun., 1884–Description of a New Species of *Aucella* from the Cretaceous Rocks of North-east Australia. *J. Roy. Soc. N. S. Wales,* 17. (For 1883).

——, 1902–The Cretaceous Mollusca of South Australia and the Northern Territory. *Mem. Roy. Soc. S. Aust.,* 2, (1).

——, 1907–Lower Cretaceous Fossils from the Sources of the Barcoo, Ward and Nive Rivers, South Central Queensland. Part I.– Annelida, Pelecypoda and Gasteropoda. *Rec. Aust. Mus.,* 6 (5).

ICHIKAWA, K., 1958–Zur Taxonomie und Phylogenie der triadischen "Pteriidae" (Lamellibranchia). Mit besonderer Berücksichtigung der Gattungen *Claraia, Eumorphotis, Oxytoma* und *Monotis. Palaeontographica,* III, (A).

JACK, R. L., & ETHERIDGE, R., jun., 1892–The Geology and Palaeontology of Queensland and New Guinea. Brisbane: Government Printer.

JELETZKY, J. A., 1955–Proposed Use of Plenary Powers to Preserve the Generic Name "*Aucella,*" Keyserling, 1846 (Class Lambellibranchiata, Order Anisomyaria, Family Aviculidae) and the Specific Name of its Type Species "*Avicula mosquensis,*" von Buch, 1884, and to Suppress the Generic name "*Buchia*" Rouillier, 1845. *Bull. Zool.* Nomencl. 11.

MARWICK, J., 1939–*Maccoyella* and *Aucellina* in the Taitai Series. *Trans. Proc. Roy. Soc. N. Zealand,* 65.

NEWELL, N. D., 1938–Late Paleozoic Pelecypods: Pectinacea. *Kansas Geol. Surv.,* 10 (2).

POMPECKJ, J. F., 1901–Ueber Aucellen und aucellenähnliche Formen. *N. Jb. Min. etc.,* BB 14.

SPRIGG, R. C., 1958–Petroleum Prospects of Western Parts of Great Australian Artesian Basin. *Bull. Amer. Ass. Petrol. Geol.,* 42 (10).

SPRIGG, R. C., & STAFF, 1958–The Great Artesian Basin in South Australia. In: The Geology of South Australia. *J. Geol. Soc. Aust.,* 5 (2). (for 1957).

WHITEHOUSE, F. W., 1926a—The Correlation of the Marine Cretaceous Deposits of Australia. *Rep. Aust. Ass. Adv. Sci.*, 18.

——, 1926b—The Cretaceous Ammonoidea of Eastern Australia. *Mem. Queensland. Mus.*, 8 (3).

——, 1927—Additions to the Cretaceous Ammonite Fauna of Eastern Australia. *ibid.*, 9 (1).

——, 1928—Additions to the Cretaceous Ammonite Fauna of Eastern Australia, Pt. 2: Desmoceratidae. *ibid.*, 9, (2).

WOODS, H., 1905—A monograph of the Cretaceous Lamellibranchia of England. Vol. II, Pt. 2. *Palaeont. Soc., London*, 59.

WRIGHT, C. W., 1958—Space, Time and Species. *Proc. Geol. Ass., London*, 69 (3).

THE ANIMAL OF *AUSTROGINELLA JOHNSTONI* (Petterd).

By FLORENCE V. MURRAY, M.Sc.*

(Text fig. 1-2.)

Marginella johnstoni (Petterd), 1884, *J. Conch.*, 4, p. 143.

Adult shell: 7 mm. to 10 mm. in length.

Living speciments of this species were located by Mr. C. E. Collinson near McCrae, Port Phillip Bay, Victoria, during a field day organized by the Malacological Society of Australia on 29/3/1959. Just beyond low water, they were inhabiting an area which extended east-west for at least a mile, and were thickly populated in some places but sparse in others. Some were on the surface, but mostly they could be found by feeling for them at the end of their six-to-eight-inch long tracks, or by screening the sand with a small handsieve. They were extremely lively, quickly climbing out of the collection jars; some kept for observations lived for six weeks in a small petri dish of sea-water and sand changed only several times.

The animal is pale cream in colour when contracted, but translucent in extension, with dark brown, orange, yellow and white pigmentation.

The foot, when fully expanded, measures 17 mm. x 12 mm. (shell 10 mm. x 6 mm.), and generally resembles a lace mat (text fig. 1). It is furroughed anteriorly, semi-transparent, and dappled with large groups of white spots interspersed with smaller groups of orange or yellow spots.

The mantle is thin, transparent, smooth, and splashed with dark brown, orange and white, the latter predominating. It completely envelopes the shell, encroaching in three distinct lobes as indicated in text fig. 1. The left and largest lobe passes over the top of the body whorl and meets the smaller anterior right lobe well over on the right side; the posterior right lobe wraps round the apex, covers the spire and extends up and over the back of the body whorl to meet the other two lobes, the margins of the three lobes always meeting in the same positions.

The siphon is held erect, and when fully outstretched reaches 5 mm. in length. Tubular in shape, it gapes widely down the ventral line; it is bright orange or yellow at the anterior end, otherwise mainly white speckled with dark brown.

The head and tentacles are transparent, the latter having a central core harbouring pigment specks. Conspicuous black eyes are situated in swellings at the outer bases of the tentacles.

A retractile, tubular proboscis (text fig. 2) emerges from the under part of the head, just above the sole of the foot, and swings round to protrude from behind the right tentacle. It gropes about, changes shape, and is capable of extending nearly half-way down the body. On the slightest disturbance it quickly contracts back into the mouth opening.

Male animals have a large penis (text fig. 2) coming from the right side of the head.

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Acknowledgments: The author is indebted to Miss Joyce Allan for advice and support, and to Mr. Robert Burn, who initiated the work, for helpful personal communications.

REFERENCES.

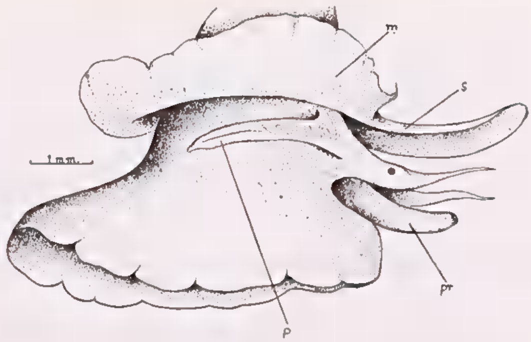
BURN R., 1958. *Vict. Nat.* 75, p. 97.

LASERON, C. F., 1957. *Aust. J. Mar. Freshw. Res.* 8, pp. 274-307.

Austroginella johnstoni (Petterd).

Text fig. 1.

Dorsal view of living animal with foot expanded, mantle encroaching over the shell, and proboscis protruding. Actual size of shell: 10 mm. x 6 mm.



Text fig. 2.

Side view of part of the body of male animal (removed from shell) with mantle (m) folded back to expose penis (p), siphon (s), proboscis (pr.).

NOTES ON LITTORINID NOMENCLATURE

By DONALD F. McMICHAEL, Ph.D.*

A revision of the nomenclature of the Australian littorinid molluscs is necessitated by Guiler's recent paper (1958) on the Tasmanian species of *Melarhaphe*. As the littorinids are key members of the littoral fauna used as marker species in studies of littoral zonation, it is important that their nomenclature should be stabilized. Guiler claimed to show that *Melarhaphe* was not an acceptable genus for the two Tasmanian species, usually listed as *Melarhaphe unifasciata* (Gray) and *M. praetermissa* (May). He considered that these species were not generically separable from *Littorina s.s.* It was considered necessary to check the data presented by Guiler and to reach some definite conclusion regarding the validity of the genus. In conjunction with this study, recent work by Abbott (1954) necessitates a revision of the nomenclature of the common *Nodilittorina*.

Guiler's paper contains a number of statements which are incorrect, so the essential facts are given here. The genus *Littorina* Ferussac 1822 was introduced on p. xxxiv of the *Tabl. Syst. des Moll.*, without included species. Iredale (1912) and other workers had assumed that Rang was the first to designate a genotype for *Littorina*, (1829, *Man. Mollusques*, p. 185), the species selected being *Nerita littoralis* L., (= *Turbo obtusatus* L.) However, Winkworth (1922) and Bequaert (1943) have shown that there is an earlier type selection for *Littorina*, by Blainville (1828), who was the first to refer definite species to *Littorina*, and selected *Turbo littoreus* Linne as type species. This, of course, must be accepted, and alters the concept of *Littorina*, because *obtusata* L. is a rather aberrant

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species. The latter species was made the type of the genus *Neritrema* Recluz by subsequent designation (Dall, 1909), so that generic name will be available for the *obtusata* series.

Iredale first introduced the name *Melarhaphe* into Australian molluscan nomenclature in 1912, and it has been generally adopted since then. Elsewhere it has been used either generically or subgenerically under *Littorina*, but, surprisingly, reinvestigation of the name reveals that it was never validly introduced and is hence unavailable. Iredale (1912) cited the original introduction of *Melarhaphe* as follows: "Commonly quoted as of Muhfeldt, this name was introduced into literature by Menke (*Synops. meth. Moll.*, 1828, p. 23), thus: *Paludina glabrata* Zgl. (*Turbo coerulescens*, Lam., T. *rupestris* Chabr., *Melarhaphe glabrata*, Mhlfld.)." Iredale and other workers, including Dall (1909), Winkworth (1922) and Bequaert (1943) have accepted this to be a valid introduction of the genus with the type species by monotypy *Paludina glabrata* Pfeiffer = *L. neritoides* (L.).

However, at the Paris Meetings of the International Congress of Zoology, 1948, it was decided that the publication of a generic name merely as the generic component of a binomen cited in the synonymy of a nominal species, did not constitute sufficient indication to make the generic name available. This decision has now been incorporated into the new rules, and therefore the introduction of *Melarhaphe* (which exactly falls within the meaning of the above decision) was invalid, and the name is not available. It is therefore necessary to find the first valid name for the taxon which has been known as *Melarhaphe*, that is, the group of species allied to *Littorina neritoides* Linne. This could be either another name with a species of "Melarhaphe" as type species, or the first valid introduction of *Melarhaphe* which would fulfil the conditions of availability.

A number of alternative introductions of *Melarhaphe* or slight emendations of this name are listed in the various "Nomenclators" such as Herrmannsen, Sherborn and Neave. It has not been possible to check all of these because of the unavailability of literature, but it appears that the generic name to be adopted will be *Melarapha* Cristifori and Jan, 1832. I am indebted to Dr. Joseph Bequaert for the information that this generic name was validly introduced as a division of *Paludina*, without characters, but monotypic for "*Paludina glabrata* Meg. (= Muhfeldt)" which correctly is *Paludina glabrata* Pfeiffer = *Littorina neritoides* (L.). Until it can be shown otherwise, *Melarapha* Cristifori and Jan will serve as an acceptable substitute for *Melarhaphe* Menke, as it differs only slightly in spelling and pronunciation so that its use will cause little confusion."

We then have to consider two generic names, *Littorina* Ferussac, with *littoreus* Linne as type, and *Melarapha* Cristifori and Jan, with *neritoides* Linne as type. Guiler states that *Melarhaphe* was never followed in Europe, and then proceeds to quote Quoy and Gaimard (1833), who used *Littorina* for *diemenensis*. This is hardly surprising, for in 1833 restricted genera like *Melarhaphe* were seldom used. Guiler also cites the Conchological Society's list of British Mollusca, in which *Littorina* is used for *obtusata* L. This again is not surprising, for at that time *obtusata* was thought to be the type species of *Littorina* and could not have been cited otherwise. In any case, *Melarhaphe* was never applicable to the *obtusata* series. Finally, Guiler cites Moore's (1937) usage of *Littorina* for *littorea* L., and Thiele's omission of *Melarhaphe* in Kukenthal's

Handbuch der Zoologie. In both cases his argument is incorrect, for *littorea* L. now known to be the type of *Littorina,* has never been considered to belong with *Melarhaphe,* and Thiele (1929) did use the name as a subgenus of *Littorina* in his *Handbuch der Systematischen Weichtierkunde,* if not in Kukenthal's *Handbuch!*

Guiler omitted to mention that Winkworth (1922) had adopted *Melarhaphe* as a full genus for the British *neritoides,* and that more recently Bequaert (1943) had allowed the name subgeneric status for western Atlantic species. Abbott (1954) has presented some data on the *Melarhaphe* subgenus of *Littorina,* which indicates that it might well be considered as a full genus. (Obviously, since *Melarhaphe* is to be replaced by *Melarapha,* which has the same type species, argument about the taxonomic status of *Melarhaphe* applies equally to *Melarapha.*)

What then is to be the fate of the Australian species commonly referred to *Melarhaphe?* Are we to adopt *Littorina,* using *Melarapha* subgenerically or are we to adopt *Melarapha* generically? This is essentially a matter of opinion, depending on the value placed on the characters separating the two groups. In my opinion, *Melarapha* is a well characterised group within the Littorinidae, distinguished by its peculiarly straight and flattened columellar, and apparently also by its egg capsule and penis structure. I therefore propose to retain *Melarapha* for such species as *unifasciatus* Gray and *praetermissa* May.

In reading Abbott's (1954) paper on Atlantic periwinkles, I noted again that the name *tuberculatus* was in use for the western Atlantic *Nodilittorina* as well as the Australian species. I had previously noticed this double usage, but at the time set it aside for further study. Abbott's paper reveals that the Atlantic usage is based on an introduction of *Littorina tuberculatus* by Menke in the *Synopsis Methodicum Molluscorum,* 1st Edition, 1828, p. 25, where reference to Gmelin's *Trochus nodulosus* var *minor* is made. The latter is an invalid name for the West Indian *Nodilittorina,* which differs in size and other characters from the Australian species. Australian workers first adopted *tuberculatus* Menke after Iredale 1924 had shown that Menke in *Verz. Conch. Samml. Malsburg,* p. 10 had used *tuberculatus* for *Trochus nodulosus* Gmelin s.s., that is, the Pacific form. Since the date of the latter paper is 1829, it is anticipated by Menke's 1828 usage, and hence the name *tuberculatus* will have to be left with the West Indian species.

This being the case, we must choose the next earliest name, which appears to be *Littorina pyramidalis* Quoy and Gaimard 1833, which Hedley (1913) used in his Check List, and so the species will return to *Nodilittorina pyramidalis* (Quoy and Gaimard). Abbott (1954) gives a synonymy for the species, which however requires further investigation. A revision of the eastern Australian Littorinidae is anticipated, and the various species will be discussed more fully there.

REFERENCES.

ABBOTT, R. T., 1954—*Proc. U.S. Nat. Mus.,* 103: pp. 449-464.

BEQUAERT, J. C., 1943—*Johnsonia,* 1, No. 7: pp. 1-28.

BLAINVILLE, M. de., 1828—*Dict. Sci. Nat.* (Ed. Levrault), 56: p. 98.

CONCHOLOGICAL SOCIETY COMMITTEE, 1901—*J. Conch.,* 10: pp. 9-27.

CRISTOFORI and JAN, 1832–*Cat. Mus.*, Sec. 2, Pt. 1. No. 1; p. 7.

DALL, W. H., 1909–*U.S. Geol. Surv. Prof. Papers*, 59: p. 79.

GUILER, E. R., 1958–*Papers Proc. Roy. Soc. Tasmania*, 92: p. 139.

HERRMANNSEN, A. N., 1847–*Indicis Generum Malacozoorum*, 2: p. 34.

IREDALE, T., 1912–*Proc. Malac. Soc. London*, 10: p. 223

MOORE, H. B., 1937–*J. Mar. Biol. Ass. U.K.* (N.S.), 21: pp. 721-742.

PHILIPPI, R. A., 1836–*Enumeratio Molluscorum Siciliae*: p. 189.

QUOY and GAIMARD, 1823–*Voyage de L'Astrolabe, Zoologie*, 2; p. 479.

THIELE, J., 1929–*Handbuch der Systematischen Weichtierkunde*, pt. 1: p. 125.

WINKWORTH, R., 1922–*Proc. Malac. Soc. London*, 14: pp. 95-97.

COMMENTS ON THE AUSTRALIAN UMBRACULACEAN MOLLUSCA

By ROBERT BURN*

(One text figure.)

For many years two Australian species of molluscs have been referred to the genus *Umbraculum* Schumacher 1817: the reasons given hereunder show why this is incorrect, and a solution to the problem is offered. The present writer, while engaged on an anatomical study of the family Umbraculidae, found that he could not obtain preserved material of the smaller Australian species, *U. corticalis* (Tate) 1889. Thus the observations made here are based purely upon shell characters, the foremost being the muscle scar inside the shell.

From the careful examination of a large series of *Umbraculum* shells, it was observed that the internal scar of the columellar muscle was complete in every case with the exception of the species, *U. corticalis* (Tate). Here the columellar muscle was open on the right side of the shell, and another smaller muscle, the intermediate suspensor muscle, nearly filled the gap between the ends of the columellar muscle. Research through literature showed that this gap in the columellar muscle and the presence of an intermediate suspensor muscle was characteristic of the genus *Tylodina* Rafinesque 1819 from the north Atlantic and north Pacific Oceans. Together with the genus *Tylodinella* Mazzarelli 1897, *Tylodina* comprises the family Tylodinidae, both genera differing from *Umbraculum* in that the columellar muscle is incomplete. A key to the families and genera

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of the suborder UMBRACULACEA is appended here in order to set out the various characteristics stated above.

A. Columellar muscle complete.

Family Umbraculidae.

Body grossly tuberculose. Shell smaller than animal.

Umbraculum Schumacher 1817.

B. Columellar muscle incomplete, open on the right side.

Family Tylodinidae.

i. Intermediate suspensor muscle present. Shell generally smaller than animal. Radula with rhachidian.

Tylodina Rafinesque 1819.

ii. Intermediate suspensor muscle absent. Shell larger than animal. Radula without rhachidian.

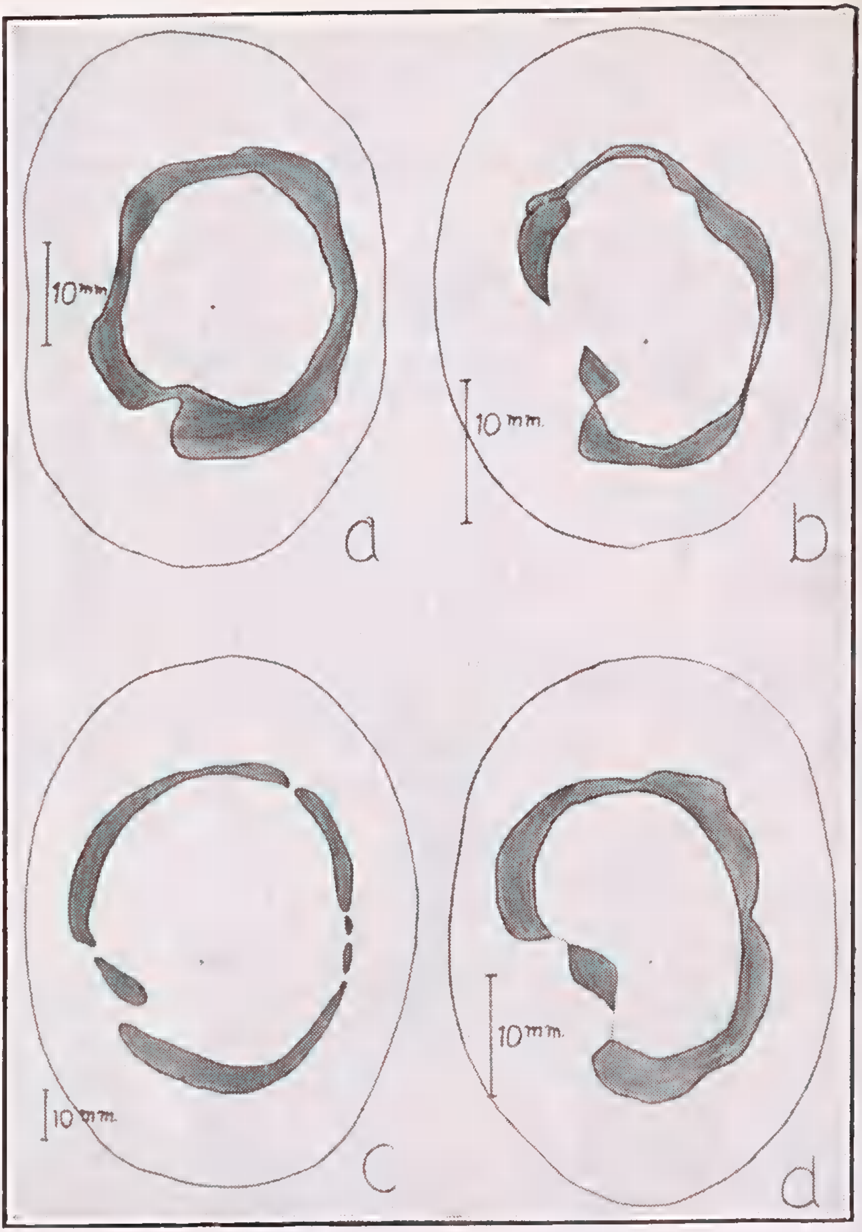
Tylodinella Mazzarelli 1897

Through the kindness of Dr. Bengt Hubendick of the Riksmuseum, Sweden, the author was able to obtain sketches of the columellar muscle formations of two differing species of *Tylodina*. These are reproduced as figures *b* and *c* on the accompanying text figure. They are respectively *b* – *T. citrina* Joannis 1834 from Puerto de Orotova, Canary Islands and *c* – *T. fungina* Gabb 1865 from Laguna Beach, California. Figure *a* represents the type species of the genus *Umbraculum, U. sinicum* Gmelin from Mauritius and shows the complete columellar muscle scar on the underside of the shell. *U. corticalis* (Tate) is represented by figure *d* and its close similarity to figures *b* and *c* can easily be seen.

Thus here *U. corticalis* (Tate) is removed from *Umbraculum* and transferred to *Tylodina,* becoming *Tylodina corticalis* (Tate). This species is by far the largest of the Tylodinids, attaining a length of 45 mm. in the largest shell yet examined by the author.

It is also worthy of note that the species *Umbraculum botanicum* Hedley 1923 from New South Wales should be reduced to a synonym of the type species, *U. sinicum* Gmelin. Likewise the author feels that all other species of *Umbraculum* should be reduced to the synonymy of *U. sinicum,* and the genus made monotypical with one circumtropical species, the type. There appear to be no differences, either conchologically or anatomically, in any of the many species attributed to the genus and as such each reverts to the synonymy of the type. The many species have arisen through various authors not having the actual animals to study and creating specific differences on colour and shell shape when both these are extremely variable, the extremes can often be found side by side in the one locality. The study of the animals is the only solution to this problem. Results of the anatomical studies of *U. sinicum* will be presented at a later date.

The author wishes to thank Dr. Bengt Hubendick of the Riksmuseum, Sweden, for sketches and information on species of *Tylodina* not available for study in Australia; the National Museum of Victoria for making available its entire collection of UMBRACULACEA; the South Australian Museum for forwarding a complete series of *Tylodina corticalis* (Tate). To Mrs. D. I. Hartley, Mr. C. Gabriel and Mr. C. Collinson, all of Melbourne, go the author's thanks for making their personal collections of UMBRACULACEA available to him.



Explanation of Text Figure.

a—Umbraculum sinicum Gmelin from Kurnell, N.S.W.
b—Tylodina citrina Joannis from Puerto de Orotova, Canary Islands.
c—Tylodina fungina Gabb from Laguna Beach, California.
d—Tylodina corticalis (Tate) from South Australia (precise locality not stated).

In each figure the underside of the shell is depicted and the muscle scars shaded.

A NEW GENUS AND SPECIES OF LAND SNAIL FROM NORTH QUEENSLAND

By DONALD F. McMICHAEL, Ph.D.,*

(One text figure.)

While the marine mollusca of eastern Australia are studied by many malacologists, both amateur and professional, only a few collectors take an interest in the terrestrial mollusca. However, collecting land snails can be very rewarding from a scientific point of view, for the terrestrial mollusca are still not well known, and many species remain to be described, while the study of distribution has hardly begun. The present paper deals with one new species which appears to be quite distinct from any known Australian group.

This interesting discovery was made by a New Zealand collector, Mr. L. Price, of Kaitaia, who visited Australia between 1956 and 1959, collecting mainly in Queensland. He obtained a large number of species from many localities, and a report on some of these is in preparation. The present species immediately stood out because of its flattened, multi-coiled shell, and at first sight recalled a miniature *Trochomorpha*. However, that genus does not occur in Australia, and the new species differed in a number of important ways. The glassy texture of fresh shells and the absence of well-developed sculpture marked the shell as zonitid in the broad sense. The only Australian species at all comparable in size and shape are the two Queensland species of the genus *Theskelomensor* Iredale, (*T. lizardensis* (Pfeiffer) and *T. creon* Solem.). These are of doubtful affinity, but in any case comparison shows that this genus and the new species are quite different. The latter is not so sharply keeled, and lacks the peripheral threads and ribbed sculpture of *Theskelomensor*.

A number of dead shells were collected, but living animals could not be found. Eventually the true family position of this species may be revealed by anatomical and radula study. Temporarily it may be assigned to the family Helicarionidae, following Baker's scheme for Pacific Islands zonitids, in which he includes Iredale's family Microcystidae. The latter includes a number of Queensland shells which are nearest to the present species.

CRATERODISCUS PRICEI gen. et. sp. nov.

Description: Shell small, the largest specimen 5.3 mm. major diameter, 4.9 mm. minor diameter, discoidal, the maximum height 2.4 mm.; texture smooth, glossy zonitid facies, deeply and broadly umbilicate; whorls six, tightly coiled, sutures impressed; shell almost planate above, whorls shouldered, the sides flattened, whorls rounded beneath; shoulder bluntly keeled, the maximum diameter of the body whorl at the shoulder, the sides of the whorls receding ventrally; apical whorls smooth, adult whorls obscurely sculptured with fine lines of growth which are sometimes a little coarse and regularly spaced, more often irregular and obsolete; aperture semi-lunar, lip simple, sharp; colour translucent yellowish-white. Animal and radula unknown.

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Dimensions:

	Major Diameter	Minor Diameter	Height
Holotype	4.7 mm.	4.4 mm.	1.9 mm.
Paratype	4.5	4.1	1.7

Type Locality: Hypipamee Crater, Atherton Tableland, North Queensland. In leaf mould, common, October 1958.

Types: The holotype and five paratypes are in the Australian Museum, Register Numbers C. 62650 and 62651 respectively. Eight additional paratypes are in Mr. Price's collection.

Remarks: Craterodiscus pricei is the type of the genus *Craterodiscus* by monotypy. The genus differs from other genera of Helicarionidae in its discoidal form, shouldered whorls, combined with the broadly open umbilicus and lack of notable sculpture.

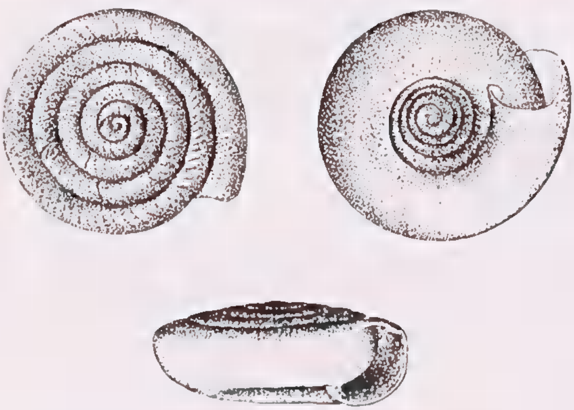
References:

BAKER, H. B. 1938-41, Zonitid Snails from Pacific Islands Parts 1, 2 and 3. *Bull. Bishop Museum,* Nos. 158, 165, 166.

IREDALE, T., 1933, Systematic Notes on Australian Land Shells. *Rec. Australian Mus.,* 19: 54.

IREDALE, T., 1937, A Basic List of the Land Mollusca of Australia Part 2. *Aust. Zoologist,* 9: 1-39.

SOLEM, A., 1958, A New Land Shell from Queensland. *Nautilus,* 72: 20-22, pl. 3, figs. 1-3.



Craterodiscus pricei McMichael. Holotype: Dorsal, Ventral and Apertural Views. B.P. Bertram del. Magnification X 6.

THEY ALL BEGAN WITH A SHELL

By A. W. B. POWELL, Ph.D.*

Money, purple dye, oil lamps, window panes, a marriage custom, certain religions and even a security pact—a curious assortment of ideas, yet all had their origin in some kind of shellfish.

When the human race was young shellfish played a much more important part in man's affairs than now, for without exercising either strength or skill coast-dwelling primitive man had a readily available supply of wholesome food in mussels, clams, oysters and whelks. The discarded shells which soon littered the camp sites of early man provided a durable material for the fashioning of rough scrapers, knives and fishhooks.

From these simple utilitarian beginnings emerged certain arts, beliefs and customs, some of which I shall now describe. Actually our monetary system and the marriage custom of throwing rice, or its modern equivalent, confetti, had a common origin in the tropical cowry shells. These shells were cherished by the ancients as symbols of good omen and in particular as fertility and regeneration charms. Collection of numbers of these shells became a necessary part of a bridal dowry, in ancient times, a custom that still prevails in the alternative fertility charm symbolised by the grain of rice. A parallel development was the employment of cowry shells as exchange for goods, an improvement on direct bartering methods.

Down the centuries cowry shell currency became standardized in the Orient, particularly in India and later in Africa. One species (*Cypraea moneta*), the money cowry, was used, and its value ranked in India during most of the nineteenth century at 3800 shells to the rupee, then equivalent to 2/- sterling.

There is a story of an Englishman resident in Bengal about 1820 who paid for the erection of his bungalow entirely in cowry shells. The sum involved was 4000 rupees, and the number of shells necessary for the transaction was sixteen million.

It requires no great stretch of the imagination to realize the significance of our slang term "shelling out," just as the term salary dates back to the early Eastern practice of payments in salt.

Many other kinds of shell money are known, but all differed in that they were manufactured, the labour and finish bestowed upon the product contributing largely to its worth.

The North American Indians had two forms of shell money, wampum of the eastern tribes, and allicochick of the Californian Indians. Wampum featured in the early days of the Hudson Bay fur trade until the company changed to a bartering method, using blankets. This form of money consisted of cylindrical beads ground from clam shells, and its value was 9d. to 1/6 per yard. The currency was declared illegal in 1862 owing to depreciation caused by unscrupulous early settlers who devised mechanical means of mass producing wampum.

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It seems that an ancient Scot first devised a receipt from shells, for an ancient legend discloses that an ordinary cockle was used for the purpose, the parties to a transaction each retaining one half of the shell. If you try to match odd valves of ordinary cockles, you will soon find that it is next to impossible to fit two disassociated halves that did not grow together.

Next we come to Tyrian Purple, a celebrated dye with the ancient Mediterranean peoples, which was manufactured from the crushed bodies of a sea shell (*Murex brandaris*), probably the first dye to be permanently fixed to wool and linen.

The art of purple dyeing probably originated in Babylon, but it was the Phoenicians who exploited the process, and their trade supremacy of the times was built up to a considerable extent by the distribution of this costly commodity.

It took thousands of shellfish to make an ounce or so of dye, and this, coupled with a long and intricate process, made the product so expensive that only the very wealthy could afford the coveted purple robes. In time the wearing of purple became the restricted privilege of kings and priests, and so to-day we have the survival of the idea in Royal purple and the Cardinal's robes.

Another article that had a primitive beginning based upon the use of a shell is the ordinary oil or kerosene lamp. It was simply a spiral type of shell suspended horizontally with strings. The cavity contained oil, obtained by rendering down sea birds and whale blubber, and in it was immersed a wick that protruded over the edge of the shell. This kind of lamp persisted in all its simplicity until a few decades ago at the Shetland Islands. I was much interested to note one of these lamps in one of the interior shots in the film "Man of Arran" which was shown in Auckland about twenty years ago.

Long before Western civilization became acquainted with the use of glass windows, the people of southern China and Malaya used the thin, semi-transparent *Placuna* shell as window panes.

Such windows persist in the Philippines, where almost every house, and even the modern multi-storied Manila hotels have their shell windows. The flat *Placuna* shells are trimmed to three-inch squares and set in latticed cedar frames. They are only semi-transparent, but admit an abundance of mellow light without heat.

Prior to the accidentally devised blotting paper, handwriting was dried by means of "pounce," a dusting powder ground from the internal shell of the cuttle-fish, a near relative of the octopus. The same creature has the ability of clouding the water with a brownish substance to facilitate escape from their enemies. This substance provided the pigment for the manufacture of the artists' colour, sepia.

A child of to-day places a sea shell to the ear and is momentarily fascinated by the illusion of sounds of sea and surf that issue from the shell. The child of to-day, however, knows that there is bound to be a simple explanation for this minor miracle, and either dismisses the problem or with a flash of intuition associates it with the amplifying apparatus of the familiar radio. To the child-mind of ancient man these sounds of the sea associated with the shell had a much deeper significance. To

him this was the voice of the god of the sea—and thus the shell trumpet became the logical instrument for invoking any diety associated with the sea.

Actually the phenomenon is capable of simple explanation, for the shell does act as an amplifier of those sounds that are too weak to be picked up by our unaided ears. Similar but less perfect reception of these sounds may be gained by simply arching the palm of the hand over an ear.

The use of shells as trumpets is very ancient, and has become almost world-wide. They were used by primitive man away back in Neolithic times, and they are still in use by the natives of Melanesia and Polynesia.

The Maoris fashioned trumpets by cutting off the end of the spire of a shell and adding an elaborately carved wooden mouthpiece, but the Melanesians simply bored a round hole in the side of the shell at a short distance from the tip of the spire. Of the two methods, the latter seemed to produce the more resonant, deeper and better carrying note.

"To blow one's own trumpet" undoubtedly originated in the early days of the shell-trumpet. Even in Japan, where shell trumpets were used in civil affairs for issuing warnings of fires, riots and robberies, there is the current expression, "Ano hito wa hora wo-fuku," which means—he blows the triton horn, or more concisely, he is bragging.

In India a different kind of shell, the "chank," is widely used as a trumpet with special religious significance. The Brahmins recite a prayer to their god, Vishnu, who is usually depicted with a "chank" shell in his hand. All devout Brahmins possess one of these shells, which is held in the hand as the prayer to Vishnu is recited. So great is the demand for these shells in India than an important fishing industry operates for this purpose alone. Bangles and feeding spouts for babies are fashioned from the shells also, still with the same devout purpose in view.

Postage stamp collectors will find a conventionalized representation of the "chank" as the central motif in the design of the stamps of the Indian Native State of Travancore.

We must now consider the higher significance of shells with certain people. For instance, the late Dr. Malinowski, who studied the culture of the natives of the D'Entrecasteaux archipelago off the eastern end of New Guinea, records an extremely interesting social system which he termed the "Kula Ring."

This is based primarily upon the circulation of two articles of high value but of no real use; they are arm-shells made from a large *Conus* shell and necklets of red shell-discs.

The necklets, Soulava, always travel clockwise, and the arm-shells, Mwali, in the opposite direction. The exchange of these articles occasions much ceremony, and the real business of the exchange of useful commodities is transacted later between the people that have entered into partnership through the Kula exchange. Each partnership becomes a firmly established life-long affair. An old chief may in the course of his life establish relationship with a hundred or more partners in neighbouring islands, and the value of this can be readily understood when it is explained that all partners in the Kula are under mutual

obligations to trade with each other, as well as to offer protection, hospitality and assistance whenever needed.

An example of a kula expedition is as follows: A fleet sets sail from Sinaketa bound for the island of Dobu, to the south. An intermediate stay is made at the Amphlett Group, but the fleet soon sails again for Dobu, where the real ceremony of the kula takes place. Here the Dobuans present their visitors with Soulava necklaces made of *Spondylus* shells, and later much trading takes place.

All the transactions in Dobu concluded, the party receive their parting gifts, sail back, and in due time, after a year or so, the Dobuans will make their return expedition to Sinaketa, with exactly the same ceremonials and magic. On this expedition, they will receive some *Conus* armshells in exchange for the necklets previously given, and others, as advance gifts towards the next Kula transaction.

Every really good Kula article has its individual name; round each there is a sort of history and romance in the traditions of the natives.

That the kula articles are seldom worn even as ornaments and are not of any real use may make us wonder why these natives place such store upon such articles. However, Dr. Malinowski, who has written at great length upon the kula system, points out an interesting analogy that will help us to understand the natives' point of view.

He described a visit he made to Edinburgh Castle, where he was shown the Crown jewels, too ostentatious, ungainly and valuable to be worn, yet they are greatly prized for the sheer sake of possession.

Until recent years the Melanesians relied greatly upon shell as a material to fashion a variety of everyday articles. One shell, the baler or melon shell (*Melo*) served as a pot to cook the enclosed animal, by placing it in hot embers; the same shell, as the first name implies, made an excellent canoe baler. The prized item, however, was the giant clam (*Tridacna*) of the coral reefs, which sometimes attains a weight of 500 pounds and a length of over three feet. This shell, by its strength and toughness, provided the raw material for the manufacture of adzes at the Gilbert Islands, which, being of coral formation, furnished neither rock nor durable materials other than shell from which tools and weapons could be fashioned. Thus they had adzes, gouges, scrapers, drills and utensils all fashioned from shell.

With the Maori people a great variety of shellfish were used as food, but only the shell of the paua and one or two others were used. The use of paua was largely decorative for forming the flashing baleful eyes of carvings, but it served a very useful purpose also in the making of fishhooks, particularly trolling spinners for the capture of kahawai and kingfish.

In our modern civilization not many shellfish serve purposes other than for food. Most of the early usages have been supplanted by more efficient and cheaper synthetics. It probably cost the equivalent of hundreds of pounds to make an ounce of purple dye in Phoenecian times—to-day the same amount of dye can be produced by chemical means for a fraction of a penny.

One shell art still survives in the carving of cameos. Originally cameos were carved from banded onyx, a form of agate, but now a West

Indian shell (*Strombus gigas*) is used, and most of the carving is done in Italy.

A use of shellfish that will probably never die in spite of synthetic substitutes is the fashioning of pearls into articles of personal adornment.

A clever Japanese, Dr. Mikimoto, originated the now thriving Japanese pearl culture industry, the basis of which is the introduction of a small foreign body into the living oyster, which year by year coats this cause of irritation with successive layers of pearl until a fine gem results. A pearl, however, can be of no better quality than the mother-of-pearl of the oyster that forms it, and unfortunately for the Japanese the quality of the mother-of-pearl in their oyster is inferior to that of the Australian, Ceylon and Pacific Island oysters.

Certain fresh-water shells produce pearls also, and for many centuries a Scottish pearl industry was carried on. This industry is quite ancient—in fact, stories of fabulous pearls from Britain was one of the minor inducements behind Caesar's invasion of Britain.

RADULAE OF FOUR GASTEROPODS FROM SOUTH AUSTRALIA AND NEW ZEALAND

(Text figs. 1-4.)

By TADASHIGE HABE, Ph.D.*

The radulae of four gasteropod species are here described and figured. Two species are from South Australia, and two from New Zealand. The new generic name *Austrancilla* is proposed for *Baryspira edithae* (Pritchard and Gatliff) in which the opercular nucleus is situated on the pointed lower end of the operculum, and the shell is maculate. In radular formula *Austrancilla edithae* stands near *Baryspira*, but in the nature of the operculum it resembles *Turrancilla*.

1. *Anisodiloma lugubris* (Gmelin). Text fig. 1. The shell of this species has not a distinct tooth on the columellar margin of its aperture, but the radula shows close relationships with the *Monodonta* group in having the quadrate central tooth with a broad frontal margin and a large membrane on each side. This is the type species of the New Zealand genus *Anisodiloma* Finlay.

2. *Micrelenchus dilatatus* (Sowerby). Text fig. 4. The central tooth is rather narrow, and has a broad membrane on each side. This feature indicates that the genus is one of the *Cantharidus* group. This is also a New Zealand shell.

* Kyushu, Japan.

3. *Micrastraea aurea* (Jonas). Text fig. 2. The radula of this Australian species is close to that of the *Astraea* group, with a broad central tooth and four elongated lateral teeth.

4. *Austrancilla edithae* (Pritchard and Gatliff), *gen. nov.* Text fig 3. This is a small ancillid species from South Australia, and is generally referred to the genus *Baryspira* with several other Australian species. The radula of this species is quite comparable with those of Japanese baryspirids, but differs from them in the operculum, the nucleus of which is situated at the pointed lower end. Moreover, the shell is slender and maculate. This species is therefore not referable to *Baryspira,* so the new generic name *Austrancilla* is proposed with this interesting species as type.

1

1. Central and five lateral teeth of *Anisodiloma lugubris* (Gmelin), from New Zealand.

2

2. Central, four lateral, and first marginal teeth of *Micrastraea aurea* (Jonas) from South Australia.

3

3. Central and marginal teeth of *Austrancilla edithae* (Pritchard and Gatliff) *gen. nov.* from South Australia.

4

4. Central and five lateral teeth of *Micrelenchus dilatatus* (Sowerby), from New Zealand.

AN INTERPRETATION OF THE MOLLUSCAN GENUS *AMPHIDESMA* IN NEW ZEALAND

By ELLIOT W. DAWSON.*

(Plate 4, text fig. 1-2.)

SUMMARY.

Amphidesma, a genus of heterodont bivalve molluscs belonging to the Mactracea, is characteristic of the sandy beaches of New Zealand; it occurs in a similar habitat in Australia, Chile, Argentina, Brazil, and in a number of places in the Northern Hemisphere.

A history of the nomenclature of these molluscs, variously described as *Amphidesma* Lamarck, 1818, or as *Mesodesma* Deshayes, 1832, is given; it is concluded that *Donacilla,* based on De Blainville's publication of Lamarck's informal name of "Donacille," is the correct name to be used for this group of molluscs. The name *Amphidesma* (although a subjective synonym of *Semele* Schumacher, 1817) is being retained only for the purposes of the present paper.

A consideration of speciation within *Amphidesma* in New Zealand, from a morphometrical study of some 35,000 specimens, shows that a cline exists from northern New Zealand to the south with a gradual lessening in height to length ratios, and increase in length of posterior end to height and to length ratios with higher latitude. The ends of the cline are marked by the "typical" *A. subtriangulatum* and *A. forsterianum* in the north and south respectively. The cline is not simple since intermediate forms may be found in many otherwise uniform populations especially in the middle region of the cline embracing the southern part of the North Island and the northern part of the South Island, and also at the Chatham Islands. The development of these forms is correlated with events in the late Tertiary and early Pleistocene, especially with the influence of the warm East Australian Current, allowing immigration of the Peronian fauna to New Zealand and with the retreat and advance of Subantarctic waters over New Zealand in the late Pliocene.

The development of *Amphidesma* has been correlated with the marine biotic provinces of New Zealand. The north end-point of the cline is the "typical" *Amphidesma subtriangulatum* in the hydrologically stable subtropical Aupourian Province and the southern end-point with "typical" *A. forsterianum* in the hydrologically stable subantarctic Forsterian Province. The intermediate populations of mid-New Zealand and the Chatham Islands, showing great variability, lie in the hydrologically unstable Cookian and Moriorian Provinces where factors of larval dispersal have been so variable that the present populations clearly reflect these environmental conditions.

Three species of *Amphidesma* are found in New Zealand. *A. australe* (easily separable subgenerically as *Paphies*) and *A. ventricosum,* the Toheroa of commerce are both quite distinct. The third "species" is composed of a complex or group of populations regarded as variants of a polytypic species with the clearly marked end-points to which the names *A.*

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subtriangulatum and *A. forsterianum* have been applied. The use of non-Linnaean "neutral terms" for informally describing these units is proposed.

The present account is offered as a preliminary to a major definitive revision of this genus now being undertaken.

INTRODUCTION.

For a number of years it has been common practice to use the name *Amphidesma* to denote a genus of bivalve molluscs characteristic of many of the sandy beaches of Australia and New Zealand, and it is, indeed, the dominant mollusc of this particular habitat in New Zealand. These bivalves, belonging to the Order Heterodonta and preferably included in the Mactracea (although some authors place them among the Tellinacea), also occur on the coasts of Chile, Argentina, and Brazil, as well as some parts of the Northern Hemisphere, where, however, they do not appear to be so dominant on the sandy shore.

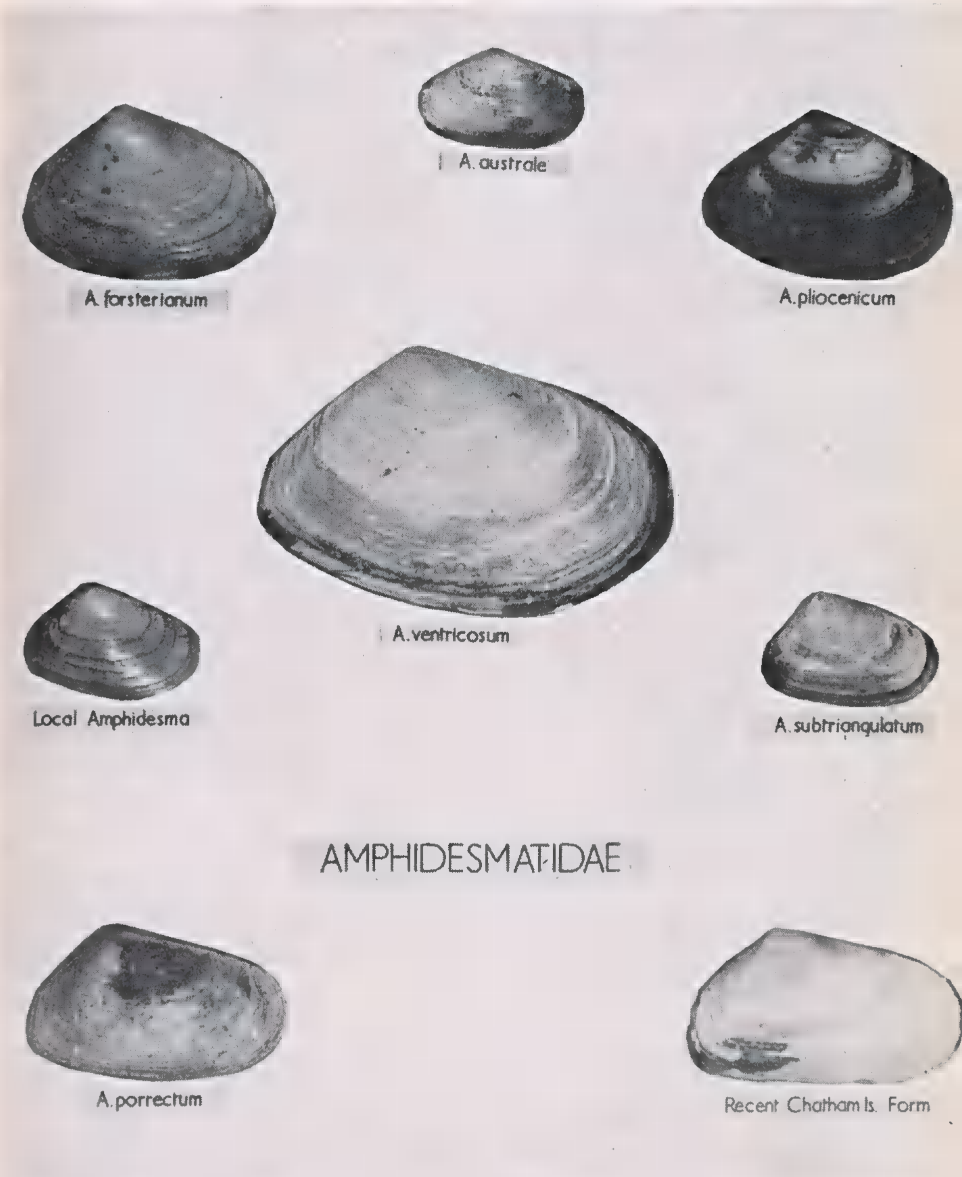
Powell's "Check List of the New Zealand Recent Mollusca" (various eds., 1937, 1946, 1957) uses the generic name of *Amphidesma*, and all recent discussions of these molluscs in New Zealand (*e.g.*) Fleming, 1951 b; Rapson, 1952, 1954; Cassie, 1951, 1955; Pilgrim, 1954 a, b; Owen, 1958; Morton, 1958) followed Powell's lead. In fact, after the discussions of this genus by Iredale (1915) and by Finlay (1927), the alternative name for the genus, that of "*Mesodesma*," has not, despite Von Ihering's (1927) attempt to do so, been used in New Zealand since the time of Suter's "Manual" (1913), although many overseas workers have tended to favour it (*e.g.*, Prashad, 1932; Coen, 1933; Thiele, 1935; Viader, 1937; Gardner, 1943; Habe, 1952; Abbott, 1955; Soot-Ryen, 1959).

In Australia, *Amphidesma* seems to have been used for a long time by various authors for the faunas of all coastlines from Western Australia to the eastern States (Hedley, 1916, 1917, 1918), not only in systematic studies (Cotton and Godfrey, 1938), but also in recent distributional and ecological work (Kershaw, 1958; Stephenson, *et al.*, 1958).

Finlay's (1927) decision "to obviate further error" in identifying the species of *Amphidesma* and his acceptance of this generic name seem to have been taken as the "last word" by subsequent workers. But this use has not always found acceptance either in other works or in other parts of the world.

There is, and always has been, a great interest in the largest species in New Zealand, *Amphidesma ventricosum* (Gray, 1843), known as the Toheroa, which is marketed as a commercial product. The recently published work of Rapson and of Cassie has revealed something of the biology of this species which appears, both by morphology and by distribution, to be quite distinct to the malacologist. However, the other species found in New Zealand have been by no means always easy to identify, and this is one reason why the literature has become encumbered with various names of doubtful status and with various remarks of doubtful significance.

A study of the biology of the common species of *Amphidesma* living on the sandy shores of Pegasus Bay, on the South Island of New Zealand, was begun some years ago (Dawson, 1954). It was found that, before any progress could be made on studies of growth, distributions and



A. australe
A. forsterianum
A. pliocenicum
A. ventricosum
Local Amphidesma
A. subtriangulatum
AMPHIDESMATIDAE
A. porrectum
Recent Chatham Is. Form

PLATE 4.

relationships, the Pegasus Bay species must be certainly identified. Even from a cursory glance it did not appear to fall directly into any of the existing named species, and, accordingly, as a necessary preliminary to the biological work, an investigation into the systematics of the genus *Amphidesma* in New Zealand had to be undertaken.

During this investigation, samples were collected from every possible part of New Zealand and from the Chatham Islands, and this material was supplemented by that already existing in various museum collections. In only certain restricted areas, such as parts of the coastline north of Auckland, where, in any case, only one "typical" form seemed to be present, were there any serious gaps in this coverage. In all about 35,000 specimens were handled during this work, and of these some 23,000 were measured in several ways for statistical analysis. It must be added that these figures, although of an order adequate to give a fairly true idea of the variability of the species concerned, are not so impressive as might appear when considered in relation to the size of the beach populations being sampled. For example, it was estimated that, during the 1953-54 summer, a 20-mile stretch of Pegasus Bay carried a population of some 1770 million individuals; this compares favourably with Coe's (1953) estimate for the smaller *Donax gouldi* of *c.* 677,600,000 individuals along a five-mile stretch of beach in California.

The purpose of the present paper is twofold. In the first place, I want to present a preliminary statement of the history of the names "*Amphidesma*" and "*Mesodesma*" as applied to certain bivalve molluscs in the Australian and New Zealand regions, and to offer the conclusion that the name *Donacilla* only should be used for these "donaciform" bivalves living in this area or elsewhere, pending further evidence to the contrary based on other interpretations of the rules for the selection of type species.

Secondly, it is thought that an outline of the systematic position of the species of *Amphidesma* in New Zealand, and of their relationships, might be of interest to Australian workers, based on my 1953-1954 survey and pending the appearance of a definitive major revision of this genus which I am attempting. The major gaps in this treatment are the lack of comparative Australian and South American material and the fact that examination of the New Zealand fossil *Amphidesma* has not been completed.

In addition to this, the present account may, perhaps, stimulate others, who may have been interested in this genus, to examine the forms occurring in their own areas.

1. STATUS OF THE NAME *AMPHIDESMA*.

In 1818, Lamarck founded the genus *Amphidesma* to include sixteen species from various parts of the world. In proposing this genus, he explained:

"Depuis assez long tems, j'avais établi ce genre dans mes cours, sous le nom de donacille (extrait du cours, etc., p. 107), parce que l'espèce que je connus d'abord avait l'aspect d'une donace" (Lamarck, 1818: 490).

Lamarck himself thought that *Amphidesma* was an artificial group, but that it seemed to be united by a number of common characters.

Immediately following Lamarck's work of 1818, confusion began. Sowerby (1820) figured Lamarck's first species, *Amphidesma variegata,* but preferred to group the genus closer to *Mactra.* Latreille (1825) placed *Amphidesma* in a family of its own, closer to *Lyonsia* rather than to *Mactra,* while, amongst other authors, De Blainville (1824) placed *Amphidesma* in the existing genus *Lucina* containing, as he put it, "espèces lenticulaires ou ovulaires."

Dubois (1824: 49), in a free translation of Lamarck's work, stated: "La Marck, on his first examination of the species of this genus, called it Donacilla, considering them to be allied to those of the G. Donax; but, on a subsequent investigation, he has determined to constitute the present genus of them, as they possess very peculiar characters, and are quite distinct from all other bivalves."

It was evident to Deshayes that certain of the species put into *Amphidesma* by Lamarck were allied not only to each other, but to some other Lamarckian species outside this genus. Hence, in 1832, he founded the new genus *Mesodesma,* to which he transferred three species of Lamarck's *Amphidesma* (*A. donacilla, A. cornea,* and *A. glabrella*), and also Lamarck's *Mactra donacia* and *Crassatella striata.* No type species was mentioned by Deshayes for Lamarck's *Amphidesma* or for his own *Mesodesma,* although his *M. donacium* has been generally taken as such by later workers. Following the practice of delimitation of genera so favoured in the nineteenth century, the remaining species of Lamarck's *Amphidesma* were similarly transferred to other genera.

Reeve (1853), in his monograph on *Amphidesma,* remarked:

> "The genus as defined by Lamarck contained rather a miscellaneous assemblage of species. Some of these have been transferred to *Thracia,* some to *Mesodesma,* and some to *Syndosmya,* and several referred to this genus by Fleming and others have shared a similar fate. Of the Lamarckian species, *A. variegatum* (*Tellina obliqua,* Wood) may be regarded as the type of the genus as now constituted."

Lamy (1912 a: 159; 1914 a: 317) has outlined the fate of the sixteen Lamarckian species; briefly, five species now belong to *Scrobicularia* or to *Syndesmya,* three to *Mesodesma,* with one to each of the genera *Ervilia, Lyonsia, Thracia, Lucina, Thyasira, Lasaea,* and *Kellia.* In this way the genus *Amphidesma* has become an "empty shell." Nevertheless, the two generic names have been used and misused a great deal not only since the decision of Deshayes in 1832, but even since Lamy's reviews of the Lamarckian genera in 1912 and 1914.

Simply, the name *Amphidesma* seems to have been used for oblong, circular, or oval shells resembling *Semele* or *Syndesmya* or *Thracia* in appearance, while *Mesodesma* has, until quite recently, generally been applied to triangular or triangularly-ovate shells superficially resembling *Donax* or *Mactra.* Few workers have taken the trouble to look inside the shells and note details of ligament disposition, hinge and teeth as carefully as did Lamy in his studies of 1912 and 1914, and, hence, the names have often been used for quite superficial resemblances according to the whims of various writers.

We need not concern ourselves here with all the details and complications of the various species involved. Lamy's great reviews of the Scrobiculariidae, including *Amphidesma,* and of the Mesodesmatidae can

be consulted by those interested in this aspect. But we can at once proceed to the basic question. What is the type species of *Amphidesma?*

Lamy (1912, 1914), with access to Lamarck's original material, decided in favour of his first listed species *A. variegatum,* and followed Deshayes in his use of the name *Mesodesma.*. However, Iredale (1915), considering the same question at about the same time, selected, "by tautonymy," *A. donacilla,* the second listed species of Lamarck, and resurrected his genus *Amphidesma* for the benefit of conchologists in New Zealand and Australia. We may re-examine these choices now.

If the type species of *Amphidesma* should be found to be a "semeliform" shell, *Mesodesma* would be available as a later name for certain allied "donaciform" or "mactroid" molluscs regrouped and removed from the original genus by Deshayes in 1832. The "elimination" of this genus *Amphidesma* is, of course, quite contrary to modern taxonomic practice, since some consideration must be made of type species. In selecting the type species of *Amphidesma* by subsequent designation, we must accept the earliest type-designation, that of J. G. Children (1823: 301) who selected *A. variegata* Lamarck. This species, the first member of the genus listed by Lamarck, has been considered by several subsequent workers to belong to the genus *Semele* as *Semele purpurascens* (Gmelin, 1792), according to Lamy (1914 a:350), and listed earlier as *Tellina* or *Semele obliqua* (Wood, 1815) by Dall (1886:279) amongst others. Although it seems obvious that Lamarck founded his new genus on a specimen reminiscent of the genus *Donax* in shape and that he put forward the name *Amphidesma* as a proper substitute for the vernacular "donacille," there seems to be little doubt that *Amphidesma* must be based on a "semeliform" rather than a "donaciform" animal other characters as portrayed by Lamarck being equal. Sowerby's (1820) figure of *A. variegatum* certainly indicates a "semeliform" species.

Since *Amphidesma,* based on a semeliform animal, is considered a subjective synonym of *Semele,* the "donaciform" members of the genus, separated by Deshayes, can now bear the name *"Mesodesma."* However, the name *Donacilla,* the Latinised version of Lamarck's "donacille" of 1812 has priority since it was first published, as Iredale (1915:490) has already shown, by De Blainville (1819:428):

> "DONACILLE, *Donacilla.* (Conchyl.) M. de Lamarck, dans l'extrait de son cours, etc., page 107, avait donné ce nom de genre á une coquille bivalve, ayant l'aspect d'une donace, qu'il a fait entrer depuis dans le genre qu'il a nommé Amphidesme. Hist. nat. des anim. sans vert., 2e édit., t. 5, p. 489 (De B.)."

Dr. L. R. Cox, F.R.S., has kindly drawn my attention to this question of priority, and has given me his opinion on the procedure necessary, and I am accordingly greatly indebted to him.

It seems that *Donacilla* must be treated as a generic name published with an indication but without an included nominal species, so that the first nominal species included in *Donacilla* becomes its type. The first author to adopt the generic name *Donacilla* Lamarck and to associate a nominal species with it was R. A. Philippi (1836:37, see also 1853:305, 311), who described a new species as *Donacilla lamarckii* and placed in its synonymy *Mactra cornea* Poli and *Amphidesma donacilla* Lamarck. This enables the adoption of the generic name *Donacilla* for the "donaciform"

members of "*Amphidesma*" and for those of Lamarck's genera which were removed to "*Mesodesma*" by Deshayes. If "*Mactra donacia* Lamarck," the type of *Mesodesma*, is considered as congeneric with the type species of *Donacilla, i.e., Amphidesma donacilla,* then only *Donacilla* is available for this group, and, in any case, it must be considered as validly published prior to *Mesodesma.* A fuller treatment of this particular section of the present paper is being offered elsewhere (Dawson, 1959).

2. THE NEW ZEALAND SPECIES OF AMPHIDESMA.

Iredale (1915) has, in detail, set out the history of early changes in the nomenclature of *Amphidesma,* and this account is expanded and criticised by Finlay (1927). Oliver's work (1923) was apparently lightly dismissed by Finlay, but, as may appear from the present study, it is possibly the closest and most clearly outlined description of the status of this genus in New Zealand.

It is not necessary here to quote extensive synonymy nor to delve deeply into the history of the genus, but the salient features may be mentioned. Deshayes (1832) had included the following presumed New Zealand species in his genus *Mesodesma*: *M. donacium* ex Lamarck, *M. quoyi sp. nov.* and *M. gaymardi sp. nov.* Dall (1895; 1898) divided "*Mesodesma*" into the subgenera *Mesodesma, Donacilla, Taria* and *Paphies,* and Suter (1913) in his great "Manual of New Zealand Mollusca" followed Dall's usage and listed the New Zealand species thus: *Mesodesma* (*Donacilla*) *subtriangulatum* (Gray, 1825), *M.* (*Taria*) *ventricosum* Gray, 1843, and *M.* (*Paphies*) *australe* (Gmelin, 1791). A key to these subgenera was also given by Suter.

Iredale's (1915) interpretation of the New Zealand species was: *Amphidesma* (*Taria*) *gaymardi* (Deshayes, 1832), *A.* (*Taria*) *quoyi* (Deshayes, 1832), *A.* (*Taria*) *ventricosum* (Gray, 1843), and *A.* (*Paphies*) *australe* (Gmelin, 1791). Looking further into the species listed by Iredale, we find that, for a number of reasons, he regarded *A. gaymardi* as the name to be used for the species included by Suter as M. *subtriangulatum* (Gray, 1825). Iredale associated this species and *A. ventricosum* in the subgenus *Taria,* as there did not appear to be much superficial distinction, and he noted that the pallial sinus was small in both *A. gaymardi* and *A. quoyi,* but deep in *A. ventricosum.* Iredale considered that Suter had confused *A. quoyi* in his description of *M. ventricosum.* Furthermore, Iredale distinguished *A. quoyi* from *A. ventricosum* in the following points: "*A. ventricosum* Gray is longer and narrower than *A. quoyi* Deshayes, and approaches *A. gaimardi [sic]* in shape. *A. quoyi* has the posterior slope flattened, while in *A. ventricosum* the posterior slope is bicarinate. In *A. quoyi* Deshayes the siphonal inflection is not deep whilst in *A. ventricosum* Gray it is very deep." Suter, in his description of *M. ventricosum,* stated that the pallial sinus is horizontal with a circular anterior end reaching not quite the middle of the shell, and he made no mention of a bicarinate posterior end. However, in his description of the subgenus *Taria,* in which he placed *M. ventricosum,* he noted: "pallial sinus well marked, sometimes deep." Hence, both of Iredale's species *A. quoyi* and *A. ventricosum* could be included in this subgenus *Taria.*

Oliver (1923) discussed the nature of *A. subtriangulatum*, and his remarks, as earlier mentioned, are worthy of some attention. He said of this species: "This appears to be a variable species, the extreme forms of which are the thick, angled, triangular form from the North, and the flattened, more ovate, form from Banks Peninsula and other localities to the South." He pointed out that, contrary to Iredale's notions, Suter had not confused *A. quoyi*, which was represented by these southern more ovate shells, with *A. ventricosum*, but had included it in his description of *A. subtriangulatum* by the use of a series probably greater than was available to Iredale. Oliver continued, interestingly, thus:

> "That we are dealing with one variable species, and not two species, is shown by the fact that variations in those characters which are supposed to separate *quoyi* from *subtriangulata* may be observed in the same locality. For instance, in shells from the Chatham Islands the angle formed by the dorsal and posterior side varies through several degrees, while shells from Takapuna vary in the thickness of the shell. While it is thus not practicable to separate a long series of shells from many localities into two species, yet those from the north-east coast between Spirits Bay and Tauranga are usually heavy ventricose shells with the posterior end short and, therefore, the angle made by the dorsal and posterior sides comparatively small. Shells from Kaipara and Gisborne southwards, and from the Chatham Islands, are almost invariably of the broad-angled, thin form. If it be convenient to refer to these differences *subtriangulata* and *quoyi* might be used subspecifically, but in this case *quoyi* would not have the meaning intended by Iredale, but include besides the greater part, so far as area of distribution goes, of the species *subtriangulata*."

Finlay (1927) attempted to end all confusion as to the species of *Amphidesma* in New Zealand. He began his criticisms by stating that Oliver's notes needed some revision since he had confounded distinct species. Oliver had, according to Finlay, misinterpreted Iredale's comments on Suter's identification of *M. quoyi* with *M. ventricosum*, and Finlay emphasised Suter's use of the expression "pallial sinus well marked, sometimes deep" in his description of the subgenus *Taria*. Finlay stated that the pallial sinus in true *ventricosum* is always deep and "so that only one conclusion is possible to account for the use of the word "sometimes," and that is that a species with a short pallial sinus had also been examined." However, one may now note that, in Suter's key to subgenera, *Taria* is characterised by the possession of a pallial sinus "reaching to near the centre" and, therefore, Oliver's suggestions, based on Suter's actual specimens and on Suter's inclusion of *M. lata* as a synonym, that *quoyi* was included by Suter in his *M. subtriangulatum* are apparently substantiated. Finlay further pointed out that one cannot adopt Oliver's suggestion of using the names "*quoyi*" and "*gaymardi*" subspecifically since both these names, and *subtriangulatum*, were given to the northern forms as is shown from a study of such published figures as are available. Finlay found, therefore, that the southern, more ovate, form was nameless, a point which concerns the species from Pegasus Bay which forms the basis of the present study. The confusion, he suggested, was due to the fact that there are two bicarinate species, *i.e., subtriangulatum* is bicarinate as well as *ventricosum*, whereas the southern shell is smooth, having no carinae on the posterior margin. Finlay's conclusion was that ". . . we can now understand how *subtriangulatum* was sometimes lumped with

the southern shell (on account of its shape and sinus), and sometimes, by Suter, with *ventricosa* (on account of its two carinae) . . ."

Finally, Finlay proposed the name "*Amphidesma forsteriana*" for this southern species. The key he gave, which implied the "last word" on the *Amphidesma* question, is given again here:

"Shell inequilateral

Adult shell posteriorly bicarinate.

Pallial sinus deep . . . . *ventricosa*

Pallial sinus shallow . . . . *subtriangulata*

Adult shell posteriorly unicarinate, sinus shallow.

Shell very high and crass, posterior dorsal area cut straight in . . . . *crassiformis*

Shell high but not crass, posterior dorsal area moderately cut in . . . . *pliocenica*

Shell neither high nor crass, posterior dorsal area rather expanded . . . . *forsteriana* n. sp.

Shell subequilateral, not carinated . . . . *australis.*"

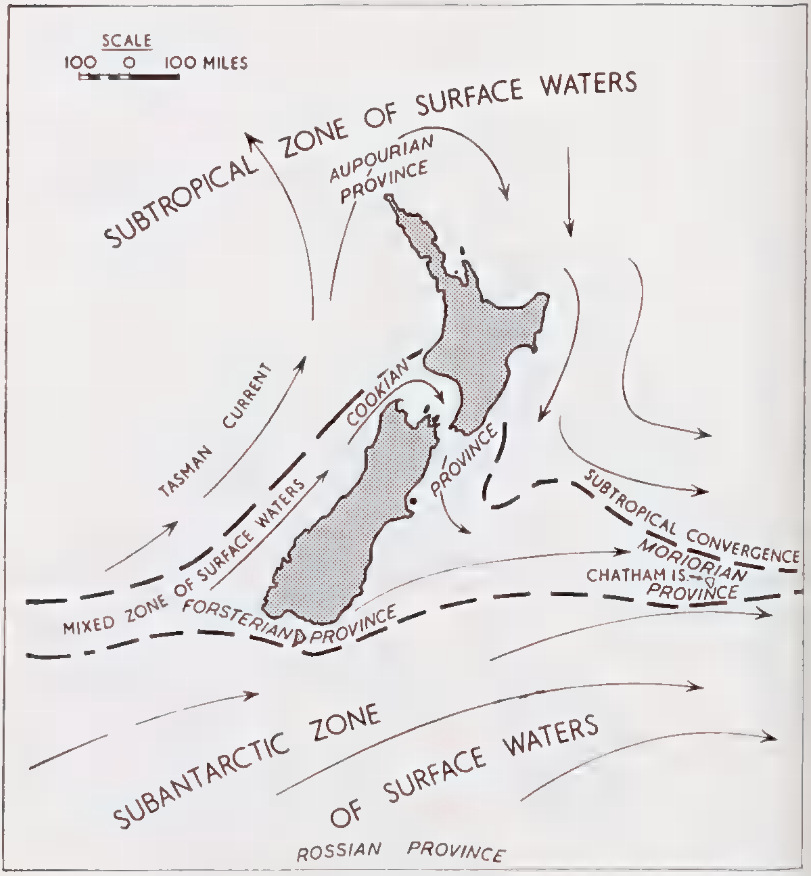
This key, since it represents the latest opinion on the New Zealand species, may be taken as the starting point for the present inquiry.

The *Amphidesma* in Pegasus Bay, the Banks Peninsula populations and those from Otago beaches all seem to fall into Finlay's *A. forsterianum* which he characterised as having an "inequilateral rather small shell not high nor crass, nor inflated; rather short anterior end in comparison with *subtriangulata,* and more produced posterior end, the beaks being therefore much less posterior; wing-like expanded posterior dorsal area, not sharply cut in, and with no distinct second medial carination, the bordering main carination being itself weak; and short pallial sinus."

On passing up the South Island into the Cook Strait region and along the Wellington coasts, we find shells appearing with characters of shape between the two extremes of *A. subtriangulatum* (= "*subtriangulata*" of Oliver) and *A. forsterianum* (= "*quoyi*" of Oliver). The Toheroa, *A. ventricosum,* is a distinct enough form although the representatives from the Southland beaches appear to be more truncated anteriorly and may, as Finlay suggested, deserve taxonomic recognition. The very small individuals of *A. ventricosum* and *A. subtriangulatum* are often rather difficult to distinguish in the field. On the Chatham Islands, 500 miles to the east of Banks Peninsula, shells occur which seem to have what might be called "*subtriangulatum* tendencies," although others appear to belong to *A. forsterianum* with populations resembling the fossil form *A. porrectum.* It is of interest, in this connection, to note Finlay's (1928: 280) remarks: "It would be very interesting if the broad, triangularly ovate, unicarinate *forsteriana* Finlay were to occur at the Chathams also, as this would prove the two forms absolutely distinct, instead of only regional relatives. Till evidence is forthcoming, however, it seems best to admit only *subtriangulata* to the Chathams fauna." A second quite distinct medial carination has sometimes been seen in "typical" *A. forsterianum* from Banks Peninsula and Otago, and in many others the bordering main carination of the posterior dorsal area is quite angled. The pallial sinus in both northern and southern forms appears similar in

size, shape and position, although individual variation exists, as may be seen by glancing at the shells forming any single natural population.

Lack of precision of the delimitation of the various forms is such that both the figure of *A. subtriangulatum* given by Suter (1915, pl. 59, fig. 19) and by Powell (1937, pl. 11, fig. 7) may be taken as representing



Text Fig. 1.

examples of the intermediate forms rather than the "typical" forms. However, Moss (1908, pl. 8, fig. 24) illustrated, under the name of *Atactodea subtriangulata*, a "typical" example of *A. subtriangulatum*. Bucknill's figure (1924, pl. 17, fig. 13) illustrates a shell close to the "typical" *subtriangulatum*. Indeed, Powell's figure could well illustrate some of the Chatham Island shells, in particular specimens which I collected in 1954 from Ko-ro-Kopuroa, near Owenga.

Of extinct species of *Amphidesma*, several have been collected in New Zealand. *A. crassiforme*, described by Marshall and Murdoch (1920) on three valves from blue sandy clay at Nukumaru (lower Pleistocene), was "distinguished by its massiveness and abrupt heavy truncation." *A. porrectum*, described by Marwick (1928) from mid to upper Pliocene soft Bryozoan limestone at Titirangi, Chatham Islands, was "distinguished from *A. subtriangulatum* by the greatly elongated anterior end, and the generally strongly convex posterior end, also the pallial sinus is deeper and the posterior muscle scar somewhat larger." Many further specimens of this form were collected in 1954 at the type locality for the present study. *A. subtriangulatum pliocenicum*, described by Oliver (1923: 187) from "the Pliocene beds at Castlecliff" (now regarded as Pleistocene), was distinguished by being "higher than either of the recent forms, and the angle of the dorsal and posterior sides is intermediate. It is more distinct from the two recent forms than they are from each other . . ." Oliver's last remark, as first pointed out by Finlay (1927), is belied by the fact that, in general, *pliocenicum* possesses no secondary carination, and it seems to be directly ancestral and quite close to *A. forsterianum*. Dell (1950) has described from a single valve an early *Amphidesma* from a Miocene bed at Waikiwhai, Auckland, as *A.* (*Paphies*) *anteaustrale*. Recent species occurring as fossils, distinguished earlier as separate species in many cases but now synonymised, have been listed by Hutton (1873, 1880), Suter (1910, 1918), and Thomson (1920), and Te Punga (1952). Finlay (1924) has listed from the Miocene of Awamoa a young shell considered to be "*Amphidesma subtriangulatum* Wood" found in very hard and rather poorly fossiliferous mudstones, now regarded as of upper Pliocene date. Finlay suggested that this shell might be "referable to the subsp. *pliocenica* Oliver." Apart from Dell's record of *Amphidesma* (*Paphies*) from the lower Miocene (Altonian), this may well be the earliest record of the genus in New Zealand if it is authentic. Dr. J. Marwick (pers. comm., 1953) has been unable to locate this specimen in the Geological Survey collections.

3. SPECIATION WITHIN AMPHIDESMA.

For the purposes of the present paper aspects of speciation and distribution of *Amphidesma* will be discussed only in general terms. Extensive data, in the form of specimens and measurements, is, however, available to substantiate statements which may be made here.

Amphidesma, although of little value to the palaeontologist concerned with happenings in the Tertiary, is a useful genus in two ways: it illustrates the variation that may occur within a single genus in recent times, and, secondly, it is a convenient model for demonstrating the status of the concept of marine biotic provinces within New Zealand.

The nature of "species" has been well dealt with on a number of occasions by Mayr (1942, 1948, 1957), and, for the palaeontologist, by Sylvester-Bradley and others (1956). Mayr has shown that, basically, there are only two species definitions: "morphological," based on the degree of difference, and "biological," based on the amount of gene interchange—in other words, on the degree of reproductive isolation. Mayr's (1942) definition of species as "groups of actually or potentially interbreeding natural populations, which are reproductively isolated from

other such groups" may be commended as a simple expression based on the population, *i.e.*, on the smallest interbreeding unit.

It appears well founded, from earlier authors' conclusions and from a consideration of the present distribution of *Amphidesma,* that there are, in New Zealand, three living "species," *A. australe, A. ventricosum* and the *A. "subtriangulatum—forsterianum" group.*. It is in the consideration of the extent and limits of this third "species" group that difficulties arise. It can be shown by examination of the ratios of length of posterior end to height (D/H) and of length of posterior end to total length (D/L) for populations of *Amphidesma* from throughout New Zealand that an apparent cline (see also, Clench, 1954) may exist in which there occurs a gradual morphometric character change with latitude. As *Amphidesma* progresses from northern New Zealand south towards Stewart Island, there is a gradual lessening of the height to length (H/L) ratio, an increase in D/H and D/L and, hence, a prolongation and expansion of the posterior end with higher latitude. The ends of the cline are marked by the "typical" *subtriangulatum* and *forsterianum* forms. This cline is not so simple, however, as it may appear. Intermediate forms may be found in many otherwise homogeneous populations. This is particularly so in the region embracing the southern part of the North Island and the northern part of the South Island and also at the Chatham Islands. Infraspecific categories have always proved a headache for taxonomists, both with recent (Mayr, 1942, 1957; Emerson, 1952), and with fossil material (Newell, 1947: Dawson, 1952; Sylvester-Bradley, *et al.*, 1956). Mayr (1942) defined the only recognised infraspecific category, the subspecies, thus: "Subspecies are geographically defined aggregates of local populations which differ taxonomically from other such subdivisions of a species." Subspecies must be considered, also, as an assemblage of local populations. Such populations are classified on these bases: geographical relationship, presence or absence of morphological difference, and of reproductive isolation.

Perhaps the populations of *Amphidesma* in the intermediate zone of this supposed cline might be thought of as marking the area of contact of two well-defined subspecies. The morphological characters of expansion of posterior end and, particularly, presence of carinae or rays do not seem to be strictly valid for designating each population, and almost every local group appears "different," so that shells may be referred to certain beaches merely by examination of the external morphology.

Despite this, instead of taking the "easy" way out and merely calling each "different" group a new species or subspecies, it seems possible to reconcile this variation with the late geological history of the New Zealand marine molluscs. Fleming (1944) and Dell (1952) have outlined the general distribution of ocean currents in relation to New Zealand. Without going into details of the oceanography involved, it may be said that a warm current from eastern Australia, the "Notonectian Current" (= East Australian or Tasman Current) strikes New Zealand in the vicinity of South Westland and travels the length of the West Coast, joining up with other water movements from the South-west Pacific to form the East Cape Current, sometimes sweeping well down to Banks Peninsula or further south during the summer. On the other hand, the cold West Wind Drift, from the Subantarctic, also approaches the South Island, sweeping eastwards towards the Chatham

Islands. In this way, a zone of so-called "mixed" waters is formed. The boundary, approximate as it may be, between the "warm" and "cold" waters, is referred to as the Subtropical Convergence, and profound influences on faunal relations have been correlated with it.

The development of the New Zealand molluscan fauna seems to have been such that, as Fleming (1944, 1949, 1951 a) has shown, several trends may be noted: (1) the evolution of an "autochthonous" element, the ancestors of which were already on the New Zealand scene in early Tertiary or even late Cretaceous times, (2) the reinforcement of such fauna by Indo-Pacific and possibly other elements during the Tertiary, (3) the extinction of mid-Tertiary genera in the Miocene and early Pliocene, and (4) the sudden immigration of species of East Australian origin in the late Pliocene and early Pleistocene, which has continued in post-Pleistocene times.

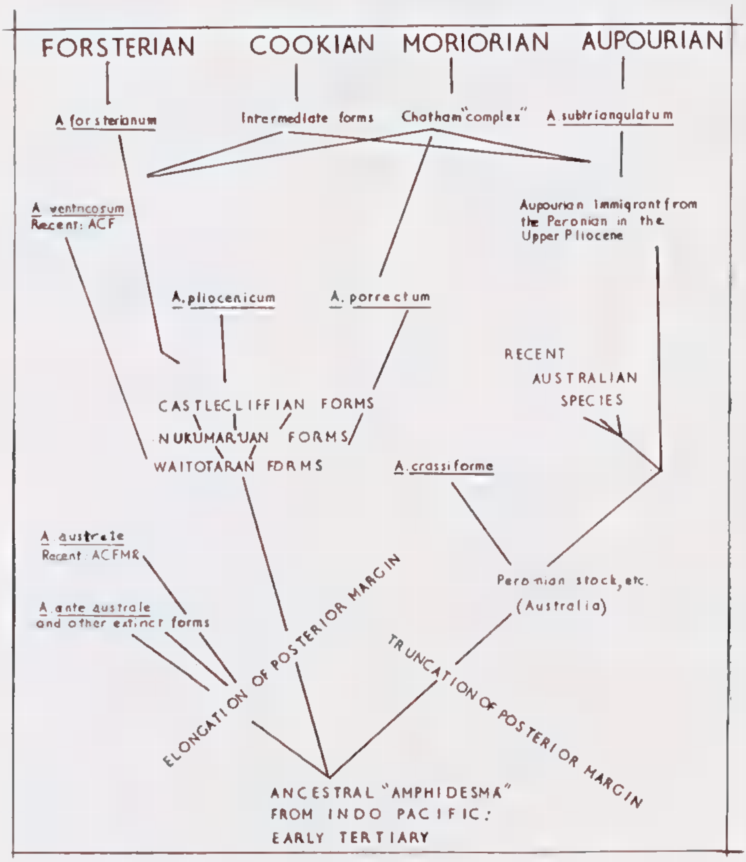
Amphidesma, in New Zealand, may be considered to appear in the Waitotaran Stage of the Upper Pliocene and in the Lower Nukumaruan Stage of the lower Pleistocene. Conditions, then, were such that there was a northward advance of cold water accompanied by migration of a number of genera of southern origin into what is now the middle of New Zealand. In this way, areas in North Canterbury, southern Hawke's Bay, and Wanganui, were affected by seas of the Subantarctic zone. In the Upper Nukumaruan, a retreat took place. *Amphidesma* may have become established in these times and some of the "odd" fossil forms, about which little data are available, may be correlated with happenings at this time. In the following stage of the Pleistocene, the Castlecliffian, the influence of the Tasman Current was felt, many genera from the east Australian sources now having suddenly appeared. This is, no doubt, when *Amphidesma*, as such, became an obvious faunal element, since additional stock may have been brought in from East Australia. The presence of the Tasman Current inhibited further advance of Subantarctic waters and prevented New Zealand seas from showing the further effects of cooling which culminated in the Pleistocene glaciation.

Amphidesma "forsterianum" may be considered the recent expression of late Pliocene stock. Nukumaruan specimens suggest that the ancestral *Amphidesma*, as indicated in *A. pliocenicum* of Oliver, was of a high H/L ratio with an elongated and expanded posterior end. The hypothesis is offered here that this group of forms, gradually evolving in early Pliocene times, retreated southwards with the Notonectian influence. The Castlecliffian immigration, with the new stock of *Amphidesma*, contributed further variation and, particularly in North Auckland, *Amphidesma* of another form, with a truncated posterior end and a more massive shell, occurred, perhaps as a direct result of the immigration of Peronian fauna from East Australia or as a descendant of the fossil *A. crassiforme*. It is further suggested that, in later time, the "*forsterianum*" stock gradually moved northwards again and the "*subtriangulatum*" or Peronian stock moved southwards, a trend which may well be continuing. In another connection, it has already been shown (Dawson, 1952) with reference to changing conditions in the New Zealand climate what rapid evolution may occur in small isolated communities. The limiting factor preventing further intermixing of surface waters and dispersal of larvae from various stocks may be principally one of temperature associated with general hydrology (cf. Fleming, 1952). At this point we may conclude this

account by associating developments within *Amphidesma* with present concepts of marine faunal provinces in New Zealand.

4. DISTRIBUTION OF *AMPHIDESMA* IN RELATION TO MARINE BIOTIC PROVINCES IN NEW ZEALAND.

The division of the New Zealand (or Maorian) sub-region into faunal provinces, a province being an area within a faunal region exhibiting a marked percentage of endemism, was the result of the efforts of Iredale, Finlay, and Powell. Hydrologically, the provinces may be delimited thus: AUPOURIAN—within the Subtropical zone of surface water—North Auckland peninsula and the Three Kings Islands from above Ahipara on the west Auckland coast and Whangaroa on the east coast; COOKIAN—mixed waters of the middle region of New Zealand—rest of the North Island and the northern part of the South Island south to Westport on the west coast and Banks Peninsula on the east coast; FORSTERIAN—isolation and predominant Subantarctic waters—Otago, Southland and Stewart Island; MORIORIAN—isolation and mixed waters—the Chatham Islands; ROSSIAN—completely within the Subantarctic zone of surface water, Subantarctic islands and seas.



Text Fig. 2.

The Aupourian province seems, indeed, to be the domain of the "typical" *Amphidesma subtriangulatum,* the northern end of the so-called cline. Almost all marine organisms found in this province are characteristic of Subtropical conditions, and hence *A. subtriangulatum* here may be stenozonal, being limited by temperature considerations. On the other hand, the Forsterian province is clearly defined for most molluscs as a predominantly Subantarctic zone and is none the less so for *Amphidesma,* this being the domain of the "typical" *A. forsterianum.*

The particularly interesting provinces, from the aspect of *Amphidesma* and the dispersal of its larvae, are the Cookian and the Moriorian. The Cookian, as indicated, is within a zone of relatively mixed waters. The fluctuation in position of the Subtropical Convergence, which may be considered its northern boundary, makes this zone hydrologically unstable and hence biologically variable. Hence it is not surprising that within this zone *Amphidesma* should show great variation. It is only from Westport, on the west coast of the South Island, and from Pegasus Bay, on the east coast, that *Amphidesma* appears morphometrically stable to the south. In the north, it seems that only from about Kawhia and Tauranga, on the west and east coasts, respectively, of the North Island, does this occur, although *Amphidesma* with *"forsterian"* affinities occurs even at Manukau Heads, near Auckland.

CONCLUSIONS.

It can be seen that *Amphidesma* is a highly variable genus in New Zealand, and some doubt may be expressed as to a suitable nomenclature for the various forms, along the lines proposed by Newell (1947) or by Emerson (1952).

Amphidesma subtriangulatum pliocenicum, so named by Oliver, appears close to the recent *A. forsterianum* of Finlay, and much more distantly related to the Aupourian "typical" *A. subtriangulatum.* Hence, it might be suggested that the fossil form be raised to specific rank and, thus, that *A. forsterianum* = *A. pliocenicum.* However, since *A. subtriangulatum, sensu stricto,* is not clearly separable from the Recent Cookian *Amphidesma,* then, perhaps, the wisest thought would be to regard all these forms as variants of a polytypic species:

Aupourian, *A. subtriangulatum subtriangulatum;*

Cookian, *A. subtriangulatum cookianum;*

Forsterian, *A. subtriangulatum pliocenicum;*

Moriorian, *A. subtriangulatum moriorium.*

Systematics, as such, is useful to the ecologist for practical purposes since it enables him to have a "label" by which to refer to the particular animals with which he is dealing. As his studies become more refined, a mere label is not enough, and he will need to know precisely with which animal he is dealing and something of its relationship to other similar animals. Within the gross limits of the working needs of marine ecologists in New Zealand the above scheme may be useful until the full details of the complexes and intermediate forms, such as occur in the Moriorian and Cookian provinces due to the interplay of larval disperdal and hydrology, are made clear.

Convenient expressions, known as "neutral terms," are available for informally describing taxonomic units of doubtful status. The terms

generally used are *form*, for a single unit, and *group* or *complex*, for a number of units. Hence, form may be used when it is not known whether the unit being considered is a full species, a subspecies of a polytypic species, or merely an individual variant. The taxonomic status of the molluscs belonging to the genus *Amphidesma* in New Zealand may be resolved in the following way: *A. ventricosum* is predominantly Aupourian, extending into the Cookian with a representative, possibly the mark of a relict fauna, in the Forsterian. *A. australe* (conveniently separated subgenerically as *Paphies*) is euryzonal, extending from the Aupourian to the Forsterian and Moriorian, with a representative in the Rossian (= Antipodean). In contrast to these relatively clearly defined species, there is what may be called the *Amphidesma subtriangulatum* Group or Complex. Since a non-Linnaean terminology is to be preferred, the varieties found in each marine province may be referred to as the Apourian Form, the Cookian Form, and the Forsterian Form, with the mixed populations of the Chatham Islands, where the situation seems especially involved, known as the Moriorian Complex.

Finally, *Amphidesma*, as a taxonomic problem, has well illustrated the change in thought of systematists within the past fifty years from the "type" concept of the nineteenth century conchologist to the "population" concept of Mayr, Dobzhansky, Simpson, and Huxley. In New Zealand, and also in Australia, it appears that the "new" systematics is yet to fill its role fully, and, while agreeing with Dell (1953) that we must bewail the state of affairs that results from "a constant search for differences, forgetting the likenesses, from a desire to name all separable forms and from a lack of appreciation of the facts of geographical variation and isolation," it is felt that the further delimitation and intensive study of populations of such variable genera as *Amphidesma* will prove invaluable in putting molluscan systematics in New Zealand, and in Australia, on a sound basis. Apart from this, it is suggested, based on the idea expressed in Occam's Razor that hypotheses should not be unnecessarily increased in number and should be phrased in the simplest possible way, that to call a "different" form a *new* species is, in these days of enlightened taxonomic thought, not sufficient, and evidence must be brought forward to show how otherwise it could not be filled into the existing framework of that particular genus or unit.

I should like to conclude by expressing my appreciation of the guidance and friendship of the late Professor E. Percival, F.R.S.N.Z., University of Canterbury, New Zealand.

REFERENCES.

ABBOTT, R. T., 1955 *American Seashells.* New York, xiv + 1-541 pp., 100 textfigs., 40 pls. (1st ptg., 1954).

BUCKNILL, C. E. R., 1924. *Sea Shells of New Zealand.* Christchurch, 123 pp., 12 pls.

CASSIE, R. M., 1951. A molluscan population of an unusual size frequency-distribution. *Nature,* 167 (4216): 284.

————, 1955. Population studies on the Toheroa, *Amphidesma ventricosum Gray* (Eulamellibranchiata) *Aust. J. Mar. Freshw. Res.,* 6 (3): 348-391.

CHILDREN, J. G., 1823. Lamarck's genera of shells. *Q.J. Sci., Lit., and Arts,* 14; 298-322, 4 pls.

CLENCH, W. J., 1954. The occurrence of clines in molluscan populations. *Syst. Zool.,* 3 (3): 122-125.

COE, W. R., 1953. Resurgent populations of littoral marine invertebrates and their dependence on ocean currents and tidal currents. *Ecology,* 34 (1): 225-229.

COEN, G., 1933. Saggio di una sylloge molluscorum Adriaticorum. *R. Comitato Talass. Ital.,* 192, vii + 186 pp., 10 pls.

COTTON, B. C., and GODFREY, F. K., 1938. *Molluscs of South Australia,* Part 1. Pelecypoda. Adelaide.

DALL, W. H., 1886. Reports on the results of dredging . . . in the Gulf of Mexico (1877-78) and in the Caribbean Sea (1879-80) by the U.S. Coast Survey Steamer "Blake." . . . XXIX. Report on the Mollusca. . . . Part I. Brachiopoda and Pelecypoda. *Bull. Mus. Comp. Zool. Harvard,* 12 (6): 171-318, 9 pls.

————, 1895. Synopsis of a review of the genera of Recent and Tertiary Mactridae and Mesodesmatidae. *Proc. Malac. Soc. Lond.,* 1 (5): 203-221.

————, 1898. Contributions to the Tertiary fauna of Florida with especial reference to the Silex beds of Tampa and the Pliocene beds of the Caloosahatchie River, including in many cases a complete revision of the generic groups treated of and their American Tertiary species. Part IV. *Trans. Wagn. Fr. Inst. Sci. Philad.,* 3 (4): viii + 571-947, pls. 23-35.

DAWSON, E. W., 1952. Subfossil *Nestor* (Psittacidae) from New Zealand. *Emu,* 52 (4): 259-272.

————, 1954. "Studies of the Biology of *Amphidesma*—an inter-tidal mollusc of the sandy shore, with particular reference to certain aspects of population distribution, fluctuation, and taxonomy." Thesis, University of Canterbury, New Zealand, 212 pp. 41 pls. [Copy in The Library, University of Canterbury.]

————, 1959. The genera *Amphidesma, Mesodesma,* and *Donacilla:* a nomenclatorial problem resolved. *Proc. Malac. Soc. Lond.,* in press.

DE BLAINVILLE, H.D.M., 1819. Mollusques, pp. 1-392, in *Dictionnaire des Sciences Naturelles,* Paris, 32: 1-567.

DELL, R. K., 1950. A Tertiary molluscan fauna from Waikiwhai, Manukau Harbour, Auckland. *Dom. Mus. Rec. Zool.,* 4: 29-37.

————, 1952. Ocean currents affecting New Zealand. Deductions from the drift bottle records of H. C. Russell. *N.Z. J. Sci. Tech.* B, 34 (2): 86-91.

————, 1953. The position of systematics in the biological sciences. *N.Z. Sci. Rev.,* 4: 42-44.

DESHAYES, G. P., 1832. Encyclopédie Méthodique. Histoire naturelle des Vers, 2. viii + 1-256 + 1-594 ("Amphidesme": 24-5, "Mesodesme": 441-5). Paris.

DUBOIS, C., 1824. *An Epitome of Lamarck's Arrangement of the Testacea,* London, xxxi + 1-317 pp.

EMERSON, W. K., 1952. Infra-specific terminology in marine molluscs. *Nautilus*, 65 (4): 139-142.

FINLAY, H. J., 1924. The molluscan fauna of Target Gully: Part 1. *Trans. N.Z. Inst.*, 55: 495-516.

————, 1927. A further commentary on New Zealand molluscan systematics. *Ibid.*, 57: 320-485.

————, 1928. The Recent mollusca of the Chatham Islands. *Ibid.*, 59: 232-286.

FLEMING, C. A., 1944. Molluscan evidence of Pliocene climatic change in New Zealand. *Trans. Roy. Soc. N.Z.*, 74 (3): 207-220.

————, 1949. The geological history of New Zealand. *Tuatara*, 2 (2): 72-90.

————, 1951a. Some post-Miocene changes in New Zealand environments. *N.Z. Sci. Rev.*, 9: 166-171

————, 1951 b. The molluscan fauna of western Southland (a report of the New Golden Hind Expedition, 1946). *N.Z. J. Sci. Tech.* B, 31 (5): 20-40.

————, 1952. Ecological aspects of a paleontological study. *N.Z. Sci. Rev.*, 10 (5): 60-61.

GARDNER, J., 1943. Mollusca from the Miocene and lower Miocene of Virginia and North Carolina. Part I.—Pelecypoda. *U.S.G.S. Prof. Pap.*, 199a: iv + 1-178 pp., 23 pls., tables, map.

HABE, T., 1952. *Illustrated Catalogue of Japanese Shells.* No. 22, Astartidae, Crassatellidae, Mesodesmatidae and Laternulidae: 161-172.

HEDLEY, C., 1916. A preliminary index of the mollusca of Western Australia. *J. Roy. Soc. W. Aust.*, 1: 1-77.

————, 1917. Studies on Australian mollusca. Part XIII. *Proc. Linn. Soc. N.S.W.*, 41 (4): 680-719.

————, 1918. A check-list of the marine fauna of New South Wales. Part I.—Mollusca. *J. Roy. Soc. N.S.W.*, 51 (Suppl.): 1-120.

HUTTON, F. W., 1873. *Catalogue of the Tertiary Mollusca and Echinodermata of New Zealand.* Col. Mus. & Geol. Surv. N.Z., Wellington, 48 pp.

————, 1880. *Manual of the New Zealand Mollusca.* Col. Mus & Geol. Surv. N.Z., Wellington, 224 pp.

IHERING, H. von, 1927. Die Gattung *Mesodesma* Desh., *Arch. f. Mollusk.*, 59 (4): 250-255.

IREDALE, T., 1915. A commentary on Suter's "Manual of the New Zealand Mollusca." *Trans. N.Z. Inst.*, 47: 417-497.

KERSHAW, R. C., 1958. Tasmanian intertidal mollusca. *J. Malac. Soc. Aust.*, 2: 58-100.

LAMARCK, J. B. P. A., 1812. *Extrait du Cours de Zoologie du Muséum d'Histoire naturelle* . . . Paris, 127 pp.

————, 1818. *Histoire Naturelle des Animaux Sans Vertébrês Tome* 5. Paris, 612 pp.

LAMY, E., 1912 a. Notes synonymiques sur les *Amphidesma* de Lamarck. *Bull. Mus. nat. Hist. nat.*, 18 (3): 159-166.

————, 1912 b. Sur les espéces de Lamarck appartenant au genre *Mesodesma* Deshayes. *Ibid.*, 18 (4): 245-254.

————, 1914 a. Révision des Scrobiculariidae vivants du Muséum d'Histoire Naturelle de Paris. *J. Conchyliol.*, 61 (3): 243-368, 18 textfigs., 1 pl.

————, 1914 b. Révision des Mesodesmatidae vivants du Muséum d'Histoire Naturelle de Paris. *Ibid.*, 62 (1): 1-74, 33 textfigs., 1 pl.

LATREILLE, P. A., 1825. *Familles naturelles du règne animal, exposées succinctement et dans un ordre analytique, avec l'indication de leurs genres.* Paris, 570 pp.

MARSHALL, P., and MURDOCH, R., 1920. Some Tertiary mollusca, with descriptions of new species. *Trans. N.Z. Inst.*, 52: 128-136.

MARWICK, J., 1928. The Tertiary mollusca of the Chatham Islands including a generic revision of the New Zealand Pectinidae. *Ibid.*, 58: 432-506.

MAYR, E., 1942. *Systematics and the Origin of Species.* New York, 334 pp.

————, 1948. The bearing of the New Systematics on genetical problems. The nature of species. *Advances in Genetics*, 2: 205-237.

————, *et al.*, 1957. *The Species Problem.* Amer. Assoc. Adv. Sci. Sympos., Washington, x + 1-395 pp.

MORTON, J. E., 1958. *Molluscs.* London, 232 pp., 23 figs.

MOSS, E. G. B., 1908. *The Beautiful Shells of New Zealand.* Auckland, 46 pp., 10 pls.

NEWELL, N. D., 1947. Infraspecific categories in invertebrate paleontology. *Evolution*, 1 (3): 163-171.

OLIVER, W. R. B., 1923. Notes on New Zealand pelecypods. *Proc. Malac. Soc. Lond.*, 15 (4): 179-188.

OWEN, G., 1958. Some intertidal animals of New Zealand. *Ann. Rep. Challenger Soc.*, 3 (10): 38.

PHILIPPI, R. A., 1836. *Enumeratio Molluscorum Siciliae cum viventium* tum in tellure tertiaria fossilium, quae in *itinere suo observavit.* Berlin, 1: xiv + 1-268 pp., 12 pls.

————, 1853. *Handbuch der Conchyliologie und Malacozoologie.* Halle, xx + 1-548 pp.

PILGRIM, R. L. C., 1954 a. The action of acetylcholine on the hearts of lamellibranch molluscs. *J. Physiol.*, 125 (1): 208-214.

————, 1954 b. The action of histamine on the hearts of two lamellibranch molluscs. *Ibid.*, 126 (3): 619-622.

POWELL, A. W. B., 1937. *The Shellfish of New Zealand.* Auckland, 100 pp.

PRASHAD, B., 1932. The Lamellibranchia of the Siboga Expedition. Systematic part. II. Pelecypoda (exclusive of the Pectinidae). *Siboga—Expeditie*, 118 (Monogr. 53c): 1-353, 9 pls., 1 map.

RAPSON, A. M., 1952. The Toheroa, *Amphidesma ventricosum* Gray (Eulamellibranchiata), development and growth. *Aust. J. Mar. Freshw. Res.*, 3 (2): 170-198.

————, 1954. Feeding and control of Toheroa *Amphidesma ventricosum* Gray (Eulamellibranchiata) populations in New Zealand. *Ibid.*, 5 (3): 486-512.

REEVE, L. A., 1853. *Conchologia Iconica: Or, illustrations of the shells of molluscous animals.* VIII. Monograph of the genus *Amphidesma*. London, 15 pp., 7 pls.

————, 1854. *Ibid.*, Monograph of the genus *Mesodesma.* 9 pp., 4 pls.

SCHUMACHER, C. F., 1817. *Essai d'un nouveau système des habitations des vers testacés.* Copenhagen, 287 pp. 22 pls.

SOOT-RYEN, T., 1959. Pelecypoda. Rep. Lunds Univ. Chile Exped., 1948-49, 35. *Lunds Univ. Arssk.*, (2) 55 (6): 86 pp., 4 pls.

SOWERBY, J. de C., 1820. "The Genera of Recent and Fossil Shells, for the use of students in conchology and geology . . ." I. London [without pagination].

STEPHENSON W., ENDEAN R., and BENNETT, I., 1958. An ecological survey of the marine fauna of Low Isles, Queensland. *Aust. J.*, 7, *Mar. Freshw. Res.*, 9 (2): 261-318.

SUTER, H., 1910. Recent shells found fossil in New Zealand. *Trans. N.Z. Inst.*, 42: 9-13.

————, 1913. *Manual of the New Zealand Mollusca,* with atlas of plates (1915), Wellington, 1120 pp.

————, 1918. *Alphabetical list of the New Zealand Tertiary Mollusca.* Wellington, 32 pp.

SYLVESTER-BRADLEY, P. C., *et al.*, 1956. *The Species Concept in Palaeontology.* London, vi + 1-145 pp.

TE PUNGA, M. T., 1952. Coloured fossils from New Zealand. *N.Z. J. Sci. Tech.* B, 34 (3): 154-159.

THIELE, J., 1935. "Handbuch der Systematischen Weichtierkunde." 2, Jena. viii + 779-1154 pp.

THOMSON, J. A., 1920. The Notocene geology of the Middle Waipara and Weka Pass district, North Canterbury, New Zealand. *Trans. N.Z. Inst.*, 52: 322-415.

VIADER, R., 1937. Revised catalogue of the testaceous mollusca of Mauritius and its dependencies. *Mauritius Inst. Bull.*, 1 (2): xvi + 1-112, map.

LONG TERM CHANGES IN INTERTIDAL ZONATION IN TASMANIA WITH SPECIAL REFERENCE TO THE MOLLUSCA

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(Plates 2-3; text fig. 1.)

Abstract.

A study carried out over eleven years of the intertidal zonation in Tasmania shows certain changes which take place over a long period of time. These changes affect many groups of organisms, but the most serious effect is upon the Mollusca, so that lists of molluscan species of an area can vary greatly from year to year. Interspecific competition is important in long term changes.

Introduction.

The usual method of studying the intertidal zonation is for several visits to be made to one area over a short period of time and the results then written up. In many cases the area is then abandoned completely or else visited sporadically. The present paper is based upon the results of regular visits to four localities over a period of eleven years. On each visit the shore was examined in some detail and major changes in zonation were noted. Each locality was visited once per annum at approximately the same time of the year, and some places were visited more frequently. Certain algae which are known to fluctuate seasonally in density on the shore are not included in this study. These are *Ulva lactuca* (L.), *Colpomenia sinuosa* (Roth.) Derby & Sol. and *Scytosiphon lomentarius* (Lyng.) Ag.

The ecological nomenclature used is that of Stephenson & Stephenson (1949), and the author of each species is only cited once.

It is essential to state that the phenomena recorded below have been noted on shores of a low tidal amplitude, about 2′ annual average tides with a maximum of 5′ at springs. Further, all the localities concerned suffer moderate to low wave action. The latter type of coast was selected because the fauna of coasts suffering intense wave action is liable to be severely altered by gales. Although such changes may be widespread, it is other longer period changes which are the subject of the present study.

Specific Examples of Changes.

The four localities at which regular visits were made are Dodge's Ferry, Coles Bay, Fisher Island and Blackman's Bay (text fig. 1). The results obtained at these places have been confirmed by examinations of the shore at other localities.

(1) *Dodge's Ferry.*

Dodge's Ferry is situated on a sheltered coast in southern Tasmania. One of the features of the shore in December, 1949, was the very well developed belt formed by the serpulid worm, *Galeolaria caespitosa* (Lam.). This species, of encrusting habit, formed a massive belt up to 5″ in thickness on the rocks. The spaces below and around the worm tubes

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Text Fig. 1.

were inhabited by a numerous fauna consisting of *Kellia australis* (Lam.), *Mytilus planulatus* (Lam.), *Austromytilus rostratus* (Dunker), *Lepsithais vinosa* (Lam.), *L. reticulata* (Blain.), *Sypharochiton maugeanus* Iredale & May, polynoid, phyllodocid and nereid worms and the anemone *Actinia tenebrosa* (Farq.). The molluscs may be considered as characteristic of the fauna to be expected on this part of the shore.

During the year 1950 the tube masses broke away from the rock, and instead of the thick belt of *Galeolaria* there remained only a thin scattered layer of tubes. Since 1950, there has been a slow colonization of the shore by *Galeolaria* with the result that the tubes now form a more or less continuous sheet on the rocks at the appropriate tidal level. However, there is not yet any development of the thick masses of worm tubes. Living amongst the *Galeolaria* tubes in March, 1958, and utilizing the rock as a substratum was a numerous fauna consisting of *Cominella lineolata* (Lam.), the buccinids *Lepsithais reticulata* (Blainville) and *L. vinosa,* the chitons *Poneroplax albida* (Blainville) and *Sypharochiton maugeanus* Iredale & May, the limpets *Patelloida alticostata* and *Chiazacmea flammea* (Quoy & Gaim.), the siphonarians *S. diemenensis, S. funiculata* and *S. tasmanica,* the nassariid *Tavaniotha tasmanica* (Ten.-Woods) and the thaid *Agnewia tritoniformis.*

Certain of these species are not usually associated with *Galeolaria* masses. *Poneroplax albida* generally is considered an inhabitant of the Infralittoral fringe, but is sometimes found at higher shore levels. The feeding habit of this chiton, together with its large size, prevents it from living amongst the fully developed *Galeolaria* masses. The limpets,

P. alticostata and *C. flammea,* as well as the three species of *Siphonaria* and *Tavaniotha tasmanica* also are not usually found in the *Galeolaria* belt.

In addition to the appearance of the above species, *Kellia australis* had disappeared from the tidal levels at which it was previously found. This lamellibranch requires small spaces in which to live, and this environment is usually supplied by *Galeolaria* tubes, seaweed holdfasts or by the coralline alga *Lithophyllum hyperellum* (Foslie).

In 1949, the *Galeolaria* masses were replaced at lower tidal levels by beds of *Mytilus planulatus* (Lam.), which in turn were replaced by the ascidian *Pyura stolonifera* (Heller). In 1956 the mussel beds were almost non-existant, the mussels being confined to the lower part of the *Galeolaria* belt, which extended as far as the *Pyura* belt (Plates 2 and 3). The *Pyura* belt had extended up the shore to meet *Galeolaria,* and the belt was more densely populated by ascidians.

The removal of the mussels was not caused by a gale, since the region where the beds were found is in a sheltered locality where strong enough seas for this purpose could not arise. The cause of the disappearance is not known. However, the effect upon the fauna is very great. The mussels, which were packed closely together, furnished a sheltered habitat for many species. The most common of these were *Cominella lineolata, Patelloida alticostata, Notoacmea corrosa* Oliver, *Venerupis diemenensis* Q. & G., *Kellia australis* (in byssus strands), *Ostrea virescens* Angas, *Hiatella australis* (Lam.), the crabs *Helice haswellianus* Whitelegge, *Petrolisthes elongatus* M. Edwards, *Halicarcinus ovatus* (Stimpson), numerous worms, amphipods and isopods, as well as algae such as *Ulva lactuca* L. *Polysiphonia* spp., *Laurencia botryoides* (Gaill.) and *Gigartina* sp. The barnacles *Chamaesipho columna* (Spengler) and *Chthamalus antennatus* (Darwin) lived attached to the shells of the mussels.

Consequent upon the disappearance of the mussels, the great majority of this fauna disappeared from the appropriate shore level. The only species still to be found were *Patelloida alticostata, Helice haswellianus,* and the two species of barnacles together with a few *Mytilus planulatus,* which remained either as isolated individuals or as scattered small clusters.

The recolonization of a denuded area by *Mytilus* usually starts soon after the clearing of the rocks. It was noticed at Blackman's Bay that rocks which were covered by *Mytilus* beds were very rapidly recolonized by mussels after they had been denuded by a storm (Guiler, 1954). The same process started less rapidly at Dodge's Ferry, but it has now reached a stage where mussels are common on the rocks.

The upward spread of the ascidian *Pyura stolonifera* (Heller) has already been noted. This species furnishes a habitat which is suited to some species of mollusc, notably *Acanthochiton sueurii* (Blainville), *Sypharochiton maugeanus, Amaurochiton glaucus* (Gray), *Patelloida alticostata* (Angas), *Cominella lineolata, Kellia australis, Venerupis exotica* (Lam.), *Dentimitrella lincolnensis* (Reeve), *Dicathais orbita* (Gmelin). Other species found are the echinoderms *Heliocidaris erythrogramma* (Val.), *Uniophora sinusoidea* (Perrier), *Coscinasterias calamaria* and *Tosia aurata* (Gray), the crustaceans *Halicarcinus ovatus* (Stimpson), *Petrolisthes elongatus,* and the sponges *Hymeniacidon perlevis* (Montagu) and *Tethya diploderma* (Schmidt).

(2) *Coles Bay.*

I have already drawn attention to the change in zonation at Coles Bay (Guiler, 1953). It was found in 1950 that *Mytilus planulatus* and the alga *Hormosira banksii* (Turn.) Decaisne were in very intense interspecific competition. In 1956, it was found that *Hormosira* has become more numerous and was dominant over the mussels, particularly at localities known as Honeymoon Beaches. The same situation is true at the present time. However, at the Fisheries, both in 1956 and 1958, the reverse held true, *Mytilus* having achieved dominance. These results suggest that there may be frequent changes in dominance between these two species in this area.

The *Galeolaria* belt, which was very well developed in 1950 and virtually absent in 1953, has not yet regained a place of ecological importance on the shore.

The belt formed by *Austromytilus rostratus,* but poorly developed in 1950, had extended by 1953, and by 1958 was a very prominent feature of the shore. This mussel does not have as many species associated with it as *Mytilus,* and being a smaller mussel, does not offer such an extensive habitat between the mussels and the substratum.

(3) *Fisher Island.*

This island is situated near the southern end of Flinders Island in Bass Strait, and is the site of a small Biological Station. The island was first visited in March, 1954, and subsequently in November, 1956, and February and March, 1957. During this period the most significant change has been the development of a *Hormosira* belt in the Midlittoral at the southern end of the island. In 1954, *Hormosira* was linked with *Galeolaria* as forming a joint belt on the eastern shore of the island, but since then it has spread to such an extent that it forms a band all around the island at the bottom of the *Galeolaria* belt. Correlated with the appearance of the *Hormosira,* there is an apparent lessening in the width of the *Galeolaria* belt. However, the tubes of *Galeolaria* still exist, and are occupied by worms, on the rocks among the *Hormosira* plants. There is no evidence that in recent years *Galeolaria* has formed a thick incrustation on the shores of Fisher Island, though there was a thick incrustation on sheltered parts of the island in 1957 (Guiler, Serventy and Willis, 1958). However, the typical fauna of the *Galeolaria* belt was poorly developed.

Modiolus pulex Lam. is of some local importance on Fisher Island, and supports a varied fauna consisting of *Cominella lineolata, Lepsithais vinosa, Hipponix conicus* (Schumacher), *Melanerita melanotragus, Micrastraea aurea* Jonas, *Serpulorbis sipho* (Lam.), *Fax tenuicostata* (Ten. Woods), *Sypharochiton maugeanus* and *Cryptoplax iredalei* (Ashby). The region where these mussels occur is sheltered from the waves, and has been occupied by mussels for a number of years.

Another change noted was the density of barnacle population. In 1954 there were not many barnacles on the island, but it was noted that there had been widespread and apparently successful spatfall in that year. This spatfall continued to survive, as is witnessed by the large number of *Chamaesipho* of uniform size on the shores of the island.

(4) *Blackman's Bay.*

A most interesting change has occurred in this area, where the limpets *Cellana solida* (Philippi) have become exceedingly rare or absent over much of the lower part of the Derwent estuary. In 1950, I described *Cellana* as occurring commonly at Blackman's Bay, especially on the platform at the northern end of the Bay. Examinations carried out in 1957 by myself and Dudgeon (*in litt.*) show that this limpet has become scarce over a considerable part of this coast. The reduction in the number of limpets has resulted in the virtual elimination of the Patelloid belt described earlier (Guiler, 1950). The band has been replaced by downward extension of the *Galeolaria* belt and partly by an upward extension of the *Austromytilus rostratus* belt.

Discussion.

The changes recorded above are all concerned with species which are known not to suffer large annual variations in population density. All of the species are of importance on the shore since they are concerned with the formation of belts of zonal significance. Some of the species, notably *Galeolaria, Pyura* and the mussels, are of even greater importance since they furnish an important habitat for other smaller species. Thus any major alteration in the numbers of these belt forming species will have an important effect on the shore as a whole. Not only may the zonation be changed but, if one of the habitat forming species is removed, the whole species composition of the shore may be drastically altered.

One of the features of the shores of southern Australia is the relative poverty of the fauna and flora of the upper parts of the tidal region, and that any changes in zonation thus will be noticed. The changes noted above were all observed on coasts which experienced a low tidal range of less than 5′ amplitude. Within such a narrow inter-tidal region any alteration in the belts is liable to be proportionately greater and liable to be noticed more easily than on a coast having a tidal range of 9′ or more. The absence of large growths of algae makes the observation of such changes easier.

The fact that the changes in the belts occur amongst those organisms which are found at or near Mean Sea Level (M.S.L.) may be significant. It was calculated (Guiler, 1950) that *Galeolaria* occurs at about M.S.L. and suffers from 18·71% air exposure. *Hormosira* and *Mytilus,* occurring lower on the shore than *Galeolaria,* would have a somewhat less exposure, with a maximum of 26% for *Mytilus.* In my 1950 paper, working on a semi exposed coast, I suggested that there exists a lethal level at about M.S.L. at which a large number of species "cut out." It was also noted that the level of M.S.L. varies from month to month. This variation is only slight, but it may be sufficient to furnish a very varying and critical habitat to those species that dwell at or near that level. This is shown by the fact that a number of zone forming and other species cut out at about that level.

The evidence provided by the Coles Bay observation points to there being intense interspecific competition at least between certain species at this level, namely *Hormosira* and *Galeolaria, Hormosira* and *Mytilus, Austromytilus* and *Hormosira,* while the Dodge's Ferry evidence shows that *Galeolaria* and *Pyura* and *Mytilus* are in a state of constant interspecific

pressure, the absence of *Mytilus* enabling *Galeolaria* and *Pyura* to extend their vertical ranges. The limpet *Cellana* is dependent upon a smooth rock surface of sufficient area to permit the growth of algae and subsequent grazing by the limpet. Any encroachment upon their habitat by *Galeolaria* or barnacles will result in a restriction of the range of the limpet, and this is what happened at Blackman's Bay.

Southward and Crisp (1954) noted changes in the populations of British barnacles ascribing these changes to interspecific competition combined perhaps with other causes. Endean, Kenny and Stephenson (1956) record several instances where the zonation of the Queensland shores is controlled by interspecific competition. They found that *Pyura* overgrows *Galeolaria,* and that *Galeolaria* determines the lower limit of the barnacle zone.

Although interspecific competition is of great importance in determining the zonation, the conditions may be tipped in favour of one species or another by certain undetermined causes, as noted by Southward and Crisp. One feature of these changes is that only one species is immediately affected by them.

The thick masses of *Galeolaria* form in certain usually sheltered localities, and these aggregations apparently broke away from the substratum during the same year at widely scattered places on the Tasmanian coast, e.g., at Coles Bay, near the north-east, and Dodge's Ferry, in the south-east of the State. It may have been coincidence that this occurred at about the same time, but on the other hand it may well be part of a long-term cyclic change. It certainly was not due to a gale or gales. The immediate reason for the breakdown of the masses may be a mechanical breakdown of the tubes holding the mass to the substratum due to the excessive weight of the whole structure. This explanation may well be true of one group of *Galeolaria* tubes, but it can hardly suffice for hundreds of clusters breaking down at about the same time over at least 200 miles of coast. We can postulate a cycle or rhythm in *Galeolaria* with an initial high rate of larval settlement giving uniformly growing masses of *Galeolaria* tubes leading to tube clusters reaching a state of mechanical instability at the same time. All of the individual tubes in a *Galeolaria* aggregation are not of the same size, due to the settlement of subsequent larvae, but if this settlement rate is more or less the same over the whole coast then the breakdown will occur at the same time. This uniform rate of larval settlement is very difficult to concede, and at present I feel more inclined to ascribe the changes in *Galeolaria* population to some event or series of events, which may turn out to be cyclic in nature.

In the case of *Galeolaria,* some cause or causes led to the removal of the worm tubes from the rocks, and this created a biological vacuum on the shore. The surrounding unaffected organisms responded to this by a movement into the vacant area, as was also seen when *Mytilus planulatus* left a space on the shore at Dodge's Ferry. The rate of filling of the vacuum is not rapid, both where *Pyura* and *Mytilus* are the encroaching organisms.

However, the rate of recolonization by the zone forming species which had been removed may be very rapid. Experiments carried out on *Mytilus planulatus* beds at Blackman's Bay showed a very slow encroachment rate, but on removal of the whole mussel bed by a storm, the

1

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Plate 2.

Fig. 1. *Galeolaria* masses at Dodge's Ferry, December, 1949. The shore was thickly coated with masses such as this.

Fig. 2. The shore at Dodge's Ferry, March, 1956. Note the absence of *Galeolaria* masses and mussel beds. *Pyura* (dark masses on the seaward edge of the rocks) has spread and become a dominant species.

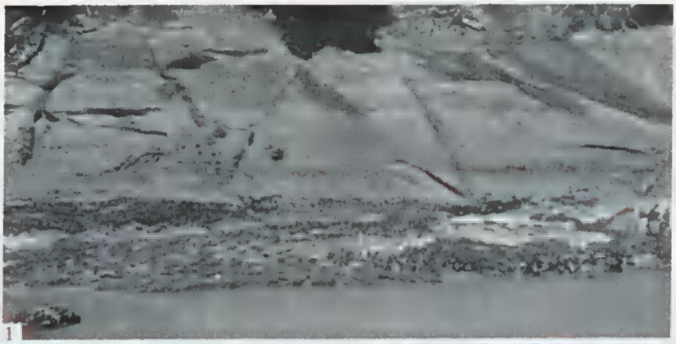

Plate 3.

Fig. 1. Honeymoon Beach, Freycinet Peninsula, January, 1950. Note absence of *Austromytilus*.

Fig. 2. The same, February, 1957. An *Austromytilus* belt is visible above the sea as an intermittent black band.

recolonization took a matter of weeks (Guiler, 1954). The association usually found with the mussels took very much longer, being dependent upon the growth of the mussels to a size sufficient to harbour the organisms of the endobiose.

To some extent, the fauna of the shore when considered as a whole may not alter much. If a *Galeolaria* association is removed and *Pyura* becomes more highly developed, certain of the organisms usually found with *Galeolaria* are often found under *Pyura*. However, this is not entirely true, and some animals disappear from the shore for as long as the association in which they occur.

Stephenson and Stephenson (1952, 1954) are strongly of the opinion that the basic zonal pattern will not change sufficiently to alter the whole

pattern of zonation. Their conclusion can be applied to the coasts of Tasmania, where none of the alterations so far observed have done any more than slightly alter the zonation.

One important fact which has emerged from this long term project is that a collecting list made on one occasion may differ very greatly in its details from that made subsequently.

REFERENCES.

ENDEAN, R. W., KENNY, R., & STEPHENSON, W., 1956.—The ecology and distribution of intertidal organisms on the rocky shores of the Queensland mainland. *Austr. J. Mar. Freshw. Res.* 7: 88-146.

GUILER, E. R.—1950: The intertidal ecology of Tasmania. *Pap. Roy. Soc. Tasm.,* 1949 (1950): 135-201.

——1953: Further observations on the intertidal ecology of the Freycinet Peninsula. *Pap. Roy. Soc. Tasm.,* 1952 (1953), pp. 93-5.

——1954: The recolonization of rock surfaces and the problem of succession. *Pap. Roy. Soc. Tasm.* 88: 49-66.

GUILER, E. R., SERVENTY, D. L., & WILLIS, J. H., 1958.— The Fisher Island Field Station, with an account of its principal fauna and flora. *Pap. Roy. Soc. Tasm.,* 92: 165-83.

SOUTHWARD, A. J., & CRISP, D. J., 1954—Recent changes in the distribution of the intertidal barnacles *Chthamalus stellatus* Poli and *Balanus balanoides* L. in the British Isles. *J. Anim. Ecol.* 23: 163-77.

STEPHENSON, T. A. & A.—1949: The universal features of zonation between tidemarks on rocky coasts. *J. Ecol.* 37: 285-305.

——1952: Life between the tidemarks in North America. II. Northern Florida and the Carolinas. *J. Ecol.* 40: 1-49.

——1954: Life between the tidemarks in North America. IIIB. Nova Scotia and Prince Edward Island. The geographical features of the region. *J. Ecol.* 42: 46-70.

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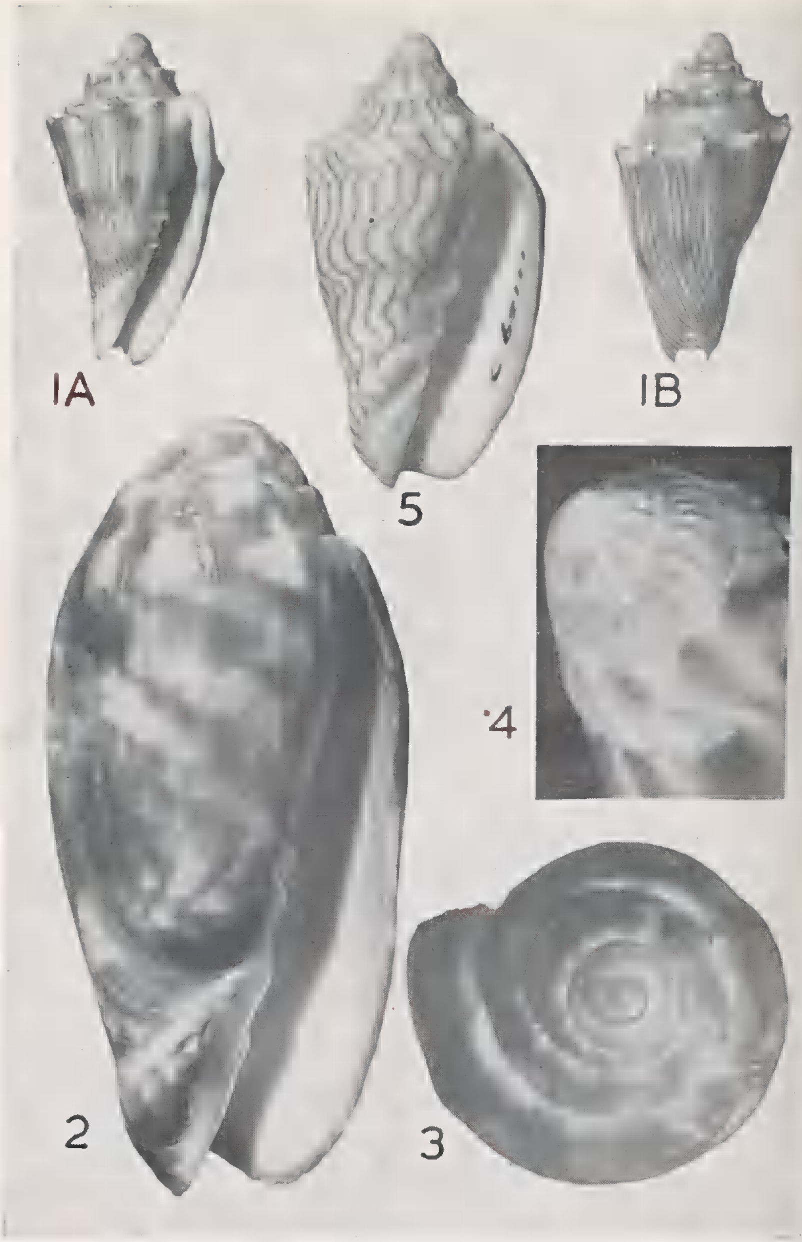

PLATE 1.

Figs. 1A, 1B. *Nannamoria parabola* Garrard. Holotype. Aust. Mus. C. 63141. Mag. 1 1/3 X.

Fig. 2. *Volutoconus coniformis* (Cox). La Grange Bay, W.A. A. Whitworth Collection. Mag. 1 1/3 X.

Continued at foot of page 3.

A NEW SPECIES OF *NANNAMORIA* (MOLLUSCA: VOLUTIDAE) FROM SOUTHERN QUEENSLAND

By T. A. GARRARD.*

The following new species of volute was collected during the fourth survey of the prawn fishery investigations made by M.V. "Challenge" along the eastern Australian coast, from November, 1959, to May, 1960.

Family Volutidae.

Genus *NANNAMORIA* Iredale.

Nannamoria Iredale, 1929, *Rec. Aust. Mus.* 17: 181. Types species by original designation, *Nannamoria amicula* Iredale, 1929, *Rec. Aust. Mus.* 17: 181, pl. 40, fig 4.

Nannamoria parabola sp. nov.

(Plate 1, figs. 1A-1B.)

Remarks: This new species is a beautiful addition to the genus, having much in common with the type species, but the shell is broader and heavier, with pronounced spines on the shoulders.

Description: Shell roughly conic in shape, spire acuminate, aperture four-fifths of the total length, recurved. Protoconch of three whorls, smooth and dome-shaped; adult shell with four additional whorls, the aperture produced at the posterior end over the spines of the preceding whorl; outer lip slightly thickened and roughly parallel with the recurved columella. Sculpture of faint growth striae, with short hollow spines on the shoulders, ten spines to each whorl, extending as pronounced axial ridges, fading towards the anterior end. Columellar plaits variable, being five and seven in two immature specimens, but no less than twelve in the adult holotype, varying considerably in size. Colour pale fawn, with fine longitudinal chestnut lines, some merging and some finishing abruptly. A band of small chestnut blotches encircles the shell in the middle of the body whorl, and another less definite below the spines, while a thickening of the chestnut lines at the anterior end suggests a third band of colour; outer lip and both ends of the inner lip white.

Dimensions: Holotype: length 35 mm., breadth 18 mm., length of aperture 29 mm.

Type Locality: All known specimens were trawled in 125 fathoms, off Moreton Island, Queensland.

Types: The holotype, a mature shell, has been presented to the Australian Museum, where it is registered as C.63141. A paratype is in the author's collection, while a second paratype is in the National Museum of Victoria, No. F.21107.

*3 The Circle, Dundas, New South Wales.

Fig. 3. *Volutoconus coniformis* (Cox). Apical view to show sculpture. Mag 1 1/3 X.

Fig. 4. *Volutoconus grossi* (Iredale). Off Yeppoon, Queensland. Apex showing radial sculpture. Mag. approx. 4 X.

Fig. 5. *Paramoria guntheri* (Smith). Encounter Bay, S.A. Aust. Mus. C. 62111. Mag. 1 1/3 X.

NOTES ON SOME AUSTRALIAN VOLUTIDAE

By DONALD F. McMICHAEL, Ph.D.*

In the course of routine museum work, a number of interesting volutes have been submitted for identification or study during the past few years. In some cases, animals have been presented from which radula slides have been prepared, and these have yielded some interesting results. The following notes are intended to record some of the conclusions reached in preparation for a comprehensive study of the Volutidae.

For convenience, the various groups will be treated in the order suggested by Pilsbry and Olsson (1954), though this does not mean complete agreement with the scheme outlined by them. Study of the Australian representatives of this family has convinced me that the Volutidae can only be understood if they are conceived of as a series of relic genera, the end products of a major Tertiary evolution, now moving towards extinction. Only a few groups are really successful recent genera with more than a few species. These include the Australian genera *Amoria, Cymbiolacca, Aulica,* the Japanese *Fulgoraria,* the New Zealand *Alcithoe,* and the large-shelled genera *Melo* and *Cymbium.*

Subfamily ATHLETINAE Pilsbry and Olsson.

Genus *TERNIVOLUTA* Martens.

Ternivoluta studeri Martens.

Reference: McMichael, 1959, *Proc. Roy. zool. Soc.* N.S.W., 1957-58, pp. 60-62, fig. 1.

Remarks: When I recorded the rediscovery of this species from Tin Can Bay, I noted that Schacko (1881) had previously figured the radula under the name *Voluta (Psephaea) concinna* (a Japanese species of *Fulgoraria*), but I did not consider the radula further. The genus *Ternivoluta* was placed next to *Volutocorbis* Dall by Thiele and by Pilsbry and Olsson, an arrangement which I followed on the shell characters, notably the columellar plaits. Study of the radula figured by Schacko shows that the species has a triserial radula very similar to that described for *Volutocorbis abyssicola* Adams & Reeve, thus confirming the generic relationship.

Since then, numerous specimens of *T. studeri* Martens were collected by the M.V. "Challenge" in December, 1959, from 68 fathoms, N.N.E. of Cape Byron, northern N.S.W. One of these contained an animal which was forwarded to me for study. This proved to be fairly typically volutid, but the siphon has no appendages (agreeing with *V. abyssicola* fide Pace (1902), p. 28). The eyes are carried at the end of short rounded eye-stalks, again agreeing with *V. abyssicola.* The colour pattern is of dark brown to black flecks and streaks over the dorsal surface of the foot, head and siphon. The radula agrees in detail with that described by Schacko, even to the exact number of rows of teeth, viz. 117; a typical row is illustrated in Text fig. 1, A.

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*Curator of Molluscs, The Australian Museum, Sydney.

Subfamily FULGORARIINAE Pilsbry and Olsson.

Genus *MESERICUSA* Iredale.

Mesericusa sowerbyi (Kiener).

Voluta sowerbyi Kiener, 1839, Coquilles Vivantes, *Voluta*, pp. 47-48, pl. 50.

Remarks: This well-known eastern Australian shell has never been studied for animal and radula morphology, though it is one of the commonest of the deep-water volutes. Iredale (1929, p. 181) separated the species under the new generic name *Mesericusa*, naming the New South Wales form *M. sowerbyi perspecta* Iredale as type. Previously the species had been referred to *Ericusa* H. and A. Adams (type species by subsequent designation, Cotton and Godfrey, 1932, *S. Aust. Nat.*, 13, p. 49, *Voluta fulgetrum* Sowerby, 1825), but Iredale separated it on conchological grounds.

The animal of *E. fulgetrum* (Sowerby) has not, to my knowledge, been studied, but the radular tooth of its congener, *E. papillosa* (Swainson) was figured by Cooke (1922, fig. 8). This has a most unusual structure, being unicuspid, with a long, narrow central cusp set on a broad basal plate. This tooth structure seems to be unique among the Volutidae, though it recalls the *Scaphella-Amoria* type of radula, as Cooke suggested. If *E. fulgetrum* (Sowerby) proves to have a similar radula, then the genus *Ericusa* would seem to stand apart from the other Australian genera assigned by Pilsbry and Olsson to the Fulgorariinae.

Mesericusa sowerbyi (Kiener) exhibits considerable variation over its range from Tasmania to north New South Wales. The large, northern specimens which Iredale named *M. sowerbyi perspecta* may constitute a geographic race, but more specimens are required to answer this question. A single preserved animal, trawled by M.V. "Challenge" in 95 fathoms off Tuggerah Lakes, N.S.W., was available. The animal is a beautiful shade of reddish-purple, with numerous cream spots, circles and ovals covering the dorsal surface of the foot, head, siphon and penis. The siphon is long, firm, with fairly long, sub-equal appendages; the head is broad, with enlarged lateral lobes and slender tentacles, the eyes situated at their bases. The penis is a huge structure, some 2 in. or 3 in. in length in the preserved specimen, about ½ in. in thickness, with an approximately round cross-section but ridged along one side, and tapering to a blunt point. In preservation the penis is curled back behind the head, with its tip hidden under the edge of the mantle, and it probably lies in this position during life.

The radula is very large, with big, tricuspid teeth, their bases deeply and evenly arched, the number of rows 61. The teeth compare in general with those of *Livonia roadnightae* (McCoy) figured by Verco (1912, pl. 16, figs. 1-2), and the number of rows in the latter (70) agrees generally. A tooth from the radula of *M. sowerbyi* is figured in Text fig. 1, B.

Subfamily CYMBIINAE H. and A. Adams.

Genus *AULICA* Gray.

Aulica Gray, 1847, *Proc. zool. Soc. Lond.*, 1847, p. 141. Type species by monotypy, *Voluta aulica* Sowerby, 1825.

Remarks: I have previously discussed the use of this generic name for Australian volutes (McMichael, 1959, p. 375). Since then I have made some effort to find out which species should bear the name *Aulica*

aulica Sowerby, but this is still in doubt. However, the generic name is certainly applicable to the series of volutes found in Queensland and northern Australia, which have been variously known under the names *flavicans* Gmelin, *scafa* Solander, *signifer* Broderip, *mariaemma* Gray, *tissotiana* Crosse, *quaesita* Iredale, and *kellneri* Iredale.

There has been much discussion among collectors as to the validity of the last two names, and in an effort to determine the matter I have considered each of these names in detail, with results as follows.

Voluta scafa Solander, 1786. This name has recently been used by Maxwell Smith (1942, p. 41) and Cotton (1949, p. 188, 189) for the spinose form of the species usually referred to as *flavicans* Gmelin. Smith (1942) included *flavicans* Gmelin, *volvacea* Lamarck, and *signifer* Broderip in the synonymy of *scafa* Solander. How this conclusion was reached I cannot understand, for reference to the Portland Catalogue, where the name *scafa* Solander was introduced, shows that it is based on a figure in Adanson (1757, pl. 3, fig. 2), which is of a species of *Cymba* generally known as *porcina* Lamarck (based on the same figure). Therefore *Voluta scafa* Solander can be rejected for the present species.

Voluta flavicans Gmelin, 1790. This species was described from unknown locality, and only a few words of description are given. However two figures are cited, Seba, Plate 67, figs. a, b, and Martini, Conch. Cab., vol. 3, pl. 95, figs. 922 and 923. Only the latter work is available to me, and it shows a shell which is unquestionably the same as some of the northern Australian specimens, including paratypes of *Aulica quaesita* Iredale. This is a small, creamish-yellow shell, with obscure dark spots, without nodules or spines of any kind on the shoulder of the whorl, and with four strong columellar plaits. If the Seba plate shows a similar shell, then there can be no doubt that the name *Aulica flavicans* (Gmelin) should be applied to the "*quaesita*" type shell. The use of the name *flavicans* for the spinose shells probably is due to Sowerby (1844) and Reeve (1849), both of whom figured spinose shells as well as smooth ones. The presence or absence of spines however seems to have no taxonomic significance. *Voluta volvacea* Lamarck is an absolute synonym of *flavicans* Gmelin.

Voluta signifer Broderip, 1848. This was described briefly without figures or exact locality, though the specimen came from a Dutch collector, so that an Indonesian locality such as Amboina is not unlikely. The description indicates one of the *quaesita* series, but the exact identity will depend on an examination of the type. Reeve (1849) noted that the shell described by Broderip "is an elongated form of *V. flavicans* in which the lip is not quite mature". If a comparison is made with the specimens of *flavicans* figured by Reeve (both of which are stout shells) it follows that *signifer* must be very like the shell generally known as *tissotiana* or *kellneri.*

Scapha maria-emma Gray, 1859. This fine shell has been regarded as a northern Australian species, but the species was described as coming from Singapore (but with the reservation that it probably came from one of the Malayan Islands, Singapore being "merely the entrepot"). Examination of the figure given by Gray shows a most unusual shell, having the general shape and proportions of a northern Australian shell, but with the colour pattern and size of the common Indo-Malayan species generally known as *scapha* Gmelin, but which correctly should be called *Volutocorona nobilis* Solander. Until the type of *mariaemma* Gray can be

examined, it can be regarded as a form of *V. nobilis* Solander and not from Australian waters. Crosse provided the substitute name *grayae* for this species, on the grounds that *Scapha maria-emma* was not binomial; however this is not considered valid reasoning to-day, the name merely being written without the hyphen.

Voluta tissotiana Crosse, 1867. This shell was described from unknown locality, but it was compared with *flavicans* and *signifer*, and the figure shows a shell without doubt from northern Australian waters. Brazier identified shells collected at the Liverpool River, Arnhem Land, by the Cadell expedition in 1868 as *tissotiana*, and the name was generally used afterwards for the larger, less shouldered specimens from northern Australia. Iredale rejected it as an Australian shell, on the grounds that the specimen, which came from Robillard of Mauritius, was not Australian, but from Mauritius or a neighbouring island. However, our knowledge of volute distribution immediately rules out this suggestion, for the genus *Aulica* occupies a discrete range (like most volutid genera), and there are almost certainly no volutes of this group to be found outside the Australian-Indonesian-Coral Sea area. Iredale claimed that North Australia was still inaccessible at the time of naming, so a locality such as Timor, Amboina, or Ceram is probable, for shells of this type occur in southern New Guinea waters. This is the same form as was later named by Iredale *kellneri*, but whether it is the same as *signifer* Broderip remains to be seen.

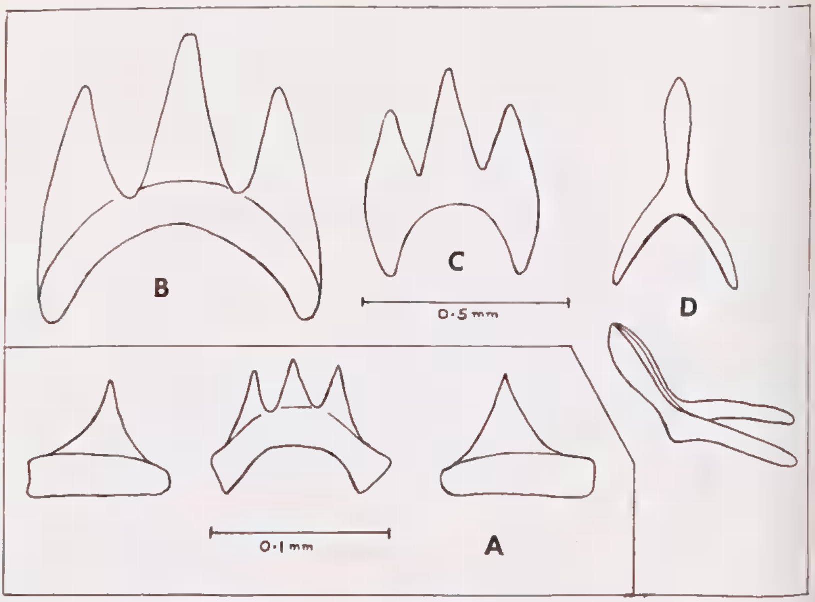
Aulica quaesita Iredale, 1956. The holotype and a series of paratypes of *Aulica quaesita* are in the Australian Museum. I am quite convinced that the series falls within the range of variation of the common northern Australian species, and this will bear the name *flavicans* Gmelin.

Aulica kellneri Iredale, 1957. This shell was separated from "*quaesita* Iredale" because of its more elongate form and spotted colour pattern. However, as indicated previously, I can see no grounds for the rejection of the earlier name *tissotiana* Crosse for this form. Whether there are two distinct species to be found in northern Australia, or only one, I am unable to decide. The series of specimens in the Australian Museum is not large enough to enable any valid conclusion to be reached. However, in view of the fact that volutes, because of their habit of laying attached eggs which hatch as crawling young, tend to develop colonies or populations of a fixed type with limited variability, but with each population differing from neighbouring ones, I think it likely that the northern Australian populations represent only a single, widespread species, which must bear the name *Aulica flavicans* Gmelin, with the names *signifer* Broderip, *tissotiana* Crosse, *quaesita* Iredale, and *kellneri* Iredale as synonyms.

Aulica flavicans (Gmelin).

Voluta flavicans Gmelin, 1790, Systema Naturae, Ed. 13, p. 3464.

Remarks: The radula and animal characters of the species *vespertilio* L. and *sophia* Gray and (in part) *rutila* Broderip are known, but as the first is the type of the subgenus *Aulicina*, while the second may also be referable to that group or to *Cymbiola*, only *rutila* Broderip refers to *Aulica* s.s.. The last named species was mentioned by Cooke (1922) as being included in the Gwatkin collection of radula slides, and Cooke noted that there were 71 rows, while the teeth had a Segmental Angle of 107°. However, the teeth were neither figured nor described. Consequently our knowledge of the typical *Aulica* radula has been strictly limited.



Text fig. 1.

Note: Figs. B, C, D are to the same scale.
A. A single row of radular teeth of *Ternivoluta studeri* Martens.
B. Radular tooth of *Mesericusa sowerbyi* (Kiener).
C. Radular tooth of *Aulica flavicans* (Gmelin).
D. Radular teeth of *Cymbiolista hunteri* Iredale, dorsal and lateral-oblique views.

A specimen of *A. flavicans* was collected alive by Mr. C. F. Kurtze, of Portland, Victoria, at Shoal Bay, near Darwin, N.T. Many specimens were seen on the mud-flats at low tide, and there were innumerable egg masses, attached to mangrove roots. Some additional information on the breeding habits of this species were given by Mr. Herbert T. Ward, of Guam, to Mrs. D. I. Hartley, of Melbourne, who kindly handed to me the specimen and Mr. Ward's notes for this paper. The specimen described is now in the Hartley collection.

The sides of the foot were a mottled purplish-brown colour, otherwise the animal is cream after some months preservation. The siphon is very prominent, stout and projecting, but not very long, with small subequal appendages. The head is small, without prominent tentacles, and with the eyes scarcely visible. The radula consists of a series of 46 tricuspid teeth, typically volutid, with arched base, long central cusp and shorter side cusps (Text fig. 1, C).

The egg masses collected by Mr. Kurtze were rather contracted in the alcohol preservative, but in life probably consisted of a number of spherical capsules, creamish-white in colour, and joined together in masses of 20 or more capsules. Each capsule of the egg masses collected contained a single, small shelled embryo, the shell consisting essentially of the protoconch of the adult, of 3½ whorls 11 mm. long by 7 mm. diameter, white with just one or two brownish markings towards the outer lip.

Mr. Ward noted that live specimens were taken on the surface of the mud in the act of laying eggs. The animal assumes a near perpendicular position with about two-thirds of the spire of the shell buried in the mud. The eggs are laid in clusters of transparent capsules attached to loose sticks or other mud-lodged debris which has been carried out by the tide. In one case two live shells were taken completely buried in the mud, with the egg mass above them, at a depth of approximately one foot. In another locality (Sampan Creek) numerous live specimens were found crawling on one small muddy area, and some specimens were again found buried under eight or ten inches of mud. However, this species must spend most of its time above the surface of the bottom mud, as the specimen dissected was carrying living barnacles of considerable size on the dorsal surface of the shell.

Genus *VOLUTOCONUS* Crosse.

Voluta (*Volutoconus*) Crosse, 1871, *J. Conchyliol.*, 19, p. 306. Type species by monotypy, *Voluta coniformis* Cox.

Remarks: Cox described *Voluta coniformis* in 1871, with an excellent figure and detailed description, from Nichol Bay, North-west Australia. The unique colour and form of the species caused Cox to write at the time "L'ensemble de ces caractères permettrait, peut-être, de créer, pour cette forme originale, une section particulière du genre *Voluta*".

This challenge was taken up by Crosse in the same year when he introduced *Volutoconus* for this species only, placing the section between "*Volutolithes* Swainson" (= *Volutocorbis* Dall) and *Callipara* Gray.

The genus received little attention subsequently, but some additional species were suggested as relatives of *V. coniformis.* First, Martens, when recording *Voluta bednalli* Brazier in the *Zoological Record* for 1879, commented "very near *coniformis Cox*", a suggestion which was accepted by Hedley (1915), who used *Volutoconus* as a subgenus of *Cymbiola* for these two species; and recently Abbott (1958) suggested that *grossi* Iredale originally described as an *Amoria,* belonged with *bednalli* in *Volutoconus,* but expressed some doubt as the animal of *V. coniformis* Cox has not been examined. He also mentioned *Voluta hargreavesi* Angas as a possible relative, because of its resemblance to *V. grossi.* Allan (1956) had previously suggested that *hargreavesi* Angas and *grossi* Iredale were synonyms.

In all the years since 1871, to my knowledge, no specimen of *Volutoconus coniformis* has been noted in literature, nor has any figure or description been given, other than those copied from the original description. It is therefore pleasing to report the rediscovery of this species from two localities in Western Australia. A magnificent shell in the collection of Mr. A. Whitworth, of Carnarvon, was generously loaned for study. It was taken alive in about ten fathoms off La Grange Bay, Cape Bossut, about 250 miles north-west of the type locality. This specimen is illustrated on Plate 1, fig. 2. A second specimen, considerably smaller and with an imperfect lip, is in the National Museum of Victoria, part of the Hartley Collection, registered as No. F.21090. This was taken by a skin-diver off Broome, W.A.

It is also of interest to record the rediscovery of *Voluta hargreavesi* Angas. This species was described without locality, but an excellent figure was given, showing a shell broader than *grossi,* with the apex flattened,

with the white triangle colour pattern on a reddish-orange ground. A specimen of this general description was reported to be in a Western Australian collection. Unfortunately, I was unable to borrow the specimen for study, but kodachromes kindly provided by Mr. Whitworth show that the shell is certainly the missing *hargreavesi.* The locality is uncertain, but probably the Abrolhos Islands, and certainly southern Western Australia.*

Study of these shells has convinced me that all four species, *coniformis* Cox, *bednalli* Brazier, *hargreavesi* Angas, and *grossi,* are members of one genus. The apical sculpture of *coniformis* consists of numerous, fine radial ribs developing after the first two whorls, which are smooth (Plate 1, fig. 3). The slides of *hargreavesi* show a very similar sculpture, and radial ribbing is also seen in good specimens of *bednalli.* The original specimens of *grossi* found some years in Tin Can Bay, Queensland, and described by Abbott (1958) were absolutely without sign of radial sculpture on the apical whorls, which were glossy, with an exsert terminal papilla. However, specimens collected recently in the general neighbourhood of Yeppoon and the Keppel Islands, do possess radially ribbed protoconchs. The ribs are more widely spaced than in the northern and western Australian species, and are covered with a glaze. A protoconch of this type is illustrated in Plate 1, figure 4.

There are some differences between the polished slender shells of *Volutoconus grossi* and those of the squat, reticulately sculptured *coniformis,* but these are linked by *hargreavesi,* which appears to have an unpolished, relatively stout, but unsculptured shell, and all share a similar colour pattern. *Voluta bednalli* Brazier differs in colour, but agrees well with one or other of the remaining species in shape, sculpture and radula tooth structure.

When Abbott (1958) described the radula of *grossi,* he was unable to give any morphological characters of the animal. A specimen of the animal, received from Mr. C. F. Knight, revealed the following features. The foot is banded with orange-red or pinkish bands on a cream background. The siphon is elongate, with long equal appendages. The head is compressed, with slender tentacles, the eyes prominent at their bases. The radula consists of 35 tricuspid teeth as noted by Abbott. It is noteworthy that the teeth are set at alternating angles on the basal membrane, so that the long central cusps are set in just the same manner as the teeth on a rip-saw.

The genus *Volutoconus* Crosse may be redefined as follows: Volutes of the subfamily Cymbiinae, with brightly coloured shells, either of blackish-brown, spiral and longitudinal bands on a cream shell, or of cream to white triangles on an orange-red to deep reddish-brown background. Spire elevated or quite depressed, apical whorls prominently radially sculptured with fine ribs, these sometimes obscured with an overlying glaze; with a central projecting papilla at the tip of the first whorl. Adult whorls in some species with fine, reticulate sculpture; in others smooth, with growth ridges only. Columellar plaits four or five, promi-

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*A second specimen, agreeing in detail with the figure and description of *V. hargreavesi* Angas, was dredged alive off the central coast of Western Australia by the "Davina" during the Hawaiian-West Australian expedition of May/June, 1960. It will be reported upon at a later date.

nently developed, or smaller, widely spaced. Radula (where known) uniserial, with about 35-40 large, tricuspid teeth.

Subfamily SCAPHELLINAE H. and A. Adams.

Genus *CYMBIOLISTA* Iredale.

Cymbiola (*Cymbiolista*) Iredale, 1929, *Rec. Aust. Mus.* 17, p. 181. Type species by original designation, *Voluta marmorata* Swainson (= *Cymbiolista hunteri* Iredale).

Remarks: Hedley (1915) referred the species *marmorata* Swainson to *Aulica*, but later transferred it to *Cymbiola* (Hedley, 1918, p. M 73). Iredale separated it subgenerically from *Cymbiola*, later (1931, p. 223) raising it to full generic rank, at the same time renaming the species, *marmorata* being preoccupied. Smith (1942, p. 52) listed the species under *Amoria* without explanation, though the shell does not resemble an *Amoria* in any way. Pilsbry and Olsson (1954) overlooked the genus, unless they regarded it as included in *Cymbiola*.

A specimen of *C. hunteri* Iredale in the Australian Museum, No. C.16374, part of the "Thetis" collection from off Cape Three Points, N.S.W., in 41-50 fathoms, revealed a typically volutid animal, but the radula was of the *Amoria* type, very long, with approximately 267 teeth, Y shaped with a single, broad blade-like central cusp, and a deeply indented basal plate (Text fig. 1,D). Thus the reference of this species to the neighbourhood of *Amoria* is confirmed, and the genus *Cymbiolista* must be placed in the present subfamily.

Genus *NANNAMORIA* Iredale.

Nannamoria Iredale, 1929, *Rec. Aust. Mus.*, 17, p. 181. Type species by original designation, *Nannamoria amicula* Iredale.

Remarks: This genus was erected for a single species dredged off Montague Island, N.S.W. No generic characters were given, apart from the species description, and no comparative characters were indicated saving the statement, "a very curious little shell, suggesting *undulata* in miniature".

Subsequently Cotton (1949) included two South Australian recent species, *guntheri* Smith and *adcocki* Tate in the genus, as well as several Victorian and Tasmanian fossil species. The discovery of a second species of *Nannamoria* described earlier in this issue prompts reconsideration of the generic classification.

The two eastern species, *amicula* Iredale and *parabola* Garrard are obviously closely related, agreeing in the slit-like mouth, rising up over the penultimate whorl posteriorly, and in the series of fine columellar plaits, alternating with somewhat larger plaits. The protoconch is small, evenly rounded without notable sculpture; the colour pattern is of fine, reddish-brown lines, somewhat wrinkled, but not undulating.

On the other hand, the two South Australian forms, *adcocki* Tate and *guntheri* Smith (which are certainly races of a single species if not merely colour forms) are very different in appearance; they have widely expanded mouths, not produced posteriorly; the four columellar plaits are of normal size; the protoconch is smoothly rounded, white, hemispherical, without any sign of radial ribbing or spiral sculpture in available specimens; the colour pattern is of spaced undulating brown lines; and the shells are nearly twice the size of the eastern species.

In view of these differences, I consider the South Australian species to be generically separable from *Nannamoria,* though a study of the tertiary fossils from southern States suggests that there may be a distant common ancestry. I regard the southern species *adcocki* and *guntheri* as more closely related to the genus *Notovoluta* Cotton (type species *Voluta kreuslerae* Angas), which has a similar protoconch and columellar plaits. The relationship of the latter with the Queensland species *perplicata* Hedley and the new Caledonian *thatcheri* McCoy, remains to be proven.

PARAMORIA gen. nov.

Type Species: *Voluta guntheri* Smith, 1886 (Plate 1, fig. 5).

Description: A genus of volutes with shells of medium to small size, spire comparatively short, body whorl large, aperture three-fifths of total length, expanded, but not produced posteriorly; columellar plaits four, stout; whorls usually angled at the shoulder, bearing a series of blunt spines or knobs; protoconch smooth, hemispherical, of 2½ whorls, of normal size.

Remarks: The recent species range from South Australia to Western Australia, and are found living in from 15-55 fathoms. The fossil species attributed by Cotton to *Nannamoria* were *costellifera* Tate, *lirata* Johnston and *absidata* Cotton. All were found in Victorian and Tasmanian tertiary beds, and because of their comparatively large size, may be related to *Paramoria,* rather than to *Nannamoria.* The animal characters and radula of both *Paramoria* and *Nannamoria* remain unknown, but when found these should throw some light on the relationship between the two groups, as well as their subfamily classification.

REFERENCES.

ABBOTT, R. T., 1958. Notes on the anatomy of the Australian volutes, *bednalli* and *grossi. J. malac. Soc. Aust.,* 2: 2-7, pl. 1, figs. 1-2.

ADANSON, M., 1757. Histoire Naturelle du Senegal. Coquillages. Paris.

ALLAN, J., 1956. The reappearance of a rare Australian volute shell, *Amoria grossi* Iredale (Mollusca: Gastropoda). *Proc. Roy. zool. Soc. N.S.W.,* 1954-55, 48-49.

BRODERIP, W. J., 1848. Description of a new species of volute. *Proc. zool. Soc. Lond.,* 1847, 232-233.

COOKE, A. H., 1922. The radula of the Volutidae. *Proc. malac. Soc. Lond.,* 15: 6-12., figs. 1-8.

COTTON, B. C., 1949. Australian recent and tertiary mollusca: Family Volutidae. *Rec. S. Aust. Mus.,* 9: 181-196, pl. 13-16.

CROSSE, H., 1867. Descriptions of d'espèces nouvelles. *J. Conchyliol.,* 15: 195-197, pl. 6, fig. 1.

GRAY, J. E., 1859. Description of *Scapha maria-emma,* a new species of volute. *Proc. zool. Soc. Lond.,* 1859, 230-231, pl. 48.

HEDLEY, C., 1915. Studies on Australian mollusca. Pt. xii. *Proc. Linn. Soc. N.S.W.,* 39: 721-725.

————1918. A check-list of the marine fauna of New South Wales, Pt. 1. Mollusca. *J. Proc. Roy. Soc. N.S.W.,* 51, Suppl., M1-M120.

IREDALE, T., 1929. Mollusca from the continental shelf of Eastern Australia, No. 2. *Rec. Aust. Mus.*, 17: 157-189, pl. 38-41.

————1931. Australian molluscan notes, No. 1. *Rec. Aust. Mus.*, 18: 201-235, pl. 22-25.

————1956. A northern Australian volute. *Proc. Roy. zool. Soc., N.S.W.*, 1954-55: 76-77.

————1957. Another Australian volute. *Proc. Roy. zool. Soc. N.S.W.*, 1955-56: 91-92.

McMICHAEL, D. F., 1959. Marine mollusca of eastern Australia 1. The genus *Cymbiolacca* Iredale (Family Volutidae). *Aust. Zool.*, 12: 374-383, pl. 44.

PACE, S., 1902. On the anatomy and relationships of *Voluta musica*, Linn.; with notes upon certain other supposed members of the Volutidae. *Proc. malac. Soc. Lond.*, 5: 21-31, pl. 2.

PILSBRY, H. A., and A. A. OLSSON, 1954. Systems of the Volutidae. *Bull. Amer. Paleontology*, 35: No. 152, 1-36, pl. 1-4.

REEVE, L., 1849. Conchologia Iconica. 6: Monograph of the genus *Voluta.*

SCHACKO, G., 1881. Radula-Untersuchungen. Martens' Conchologische Mittheilung, 2: 126-127, pl. 24, fig. 5.

SMITH, M., 1942. A review of the Volutidae (Florida).

SOLANDER, D. C., 1786. Catalogue of the Portland Museum, p. 41.

SOWERBY, G. B., 1844. Thesaurus Conchyliorum. 1: Monograph of the genus *Voluta.*, 191-220, pl. 46-55.

VERCO, J. C., 1912. Shells from the Great Australian Bight. *Trans. Roy. Soc. S. Aust.*, 36: 206-232, pl. 10-16.

CYPRAEA LEUCODON Broderip, 1828

By WILLIAM J. CLENCH, Ph.D.*

This species has heretofore been known only from a single specimen in the British Museum. The Museum of Comparative Zoology at Harvard University possesses another specimen of this remarkable mollusc.

Our specimen has no locality data other than "Indian Ocean". It was originally in the collection of the Boston Society of Natural History. In 1918, all of that society's non-New England material was transferred to the Museum of Comparative Zoology. The original catalogue number (1206) was entered very early, probably around 1840, which would indicate that this specimen, as well as that of the British Museum, was collected well over a century ago. This fact in itself may possibly give us a lead as to a probable locality.

During the early days of the East India trade, sailing vessels made stops at many islands in the Indian Ocean. Contrary winds, storms or other delays made it imperative to replenish supplies of fruits and fresh meat, particularly the former, to combat the dreaded deficiency disease of scurvy. Thus, vessels well off-course would stop at any of these remote islands to take on provisions. May not one of these islands be the locality of *C. leucodon?*

Sailors engaged in the East India trade were aware of the value of shells, as the curio stores must have depended largely upon them for the specimens which frequently found their way into the cabinets of European collectors.

One such island group, the Chagos Archipelago, is known to have at least a few remarkable endemic marine species such as *Conus barthelemyi* Bernardi and *Cypraea barclayi* Reeve. It is possible that *leucodon* may be from this remote and very small archipelago.

Bibliography:

Cypraea leucodon Broderip, 1828, *Zool. J.* 4: 163, pl. 5.

Cypraea leucodon Broderip. Reeve 1845, Conchologia Iconica. 3: (*Cypraea*), pl. 7, fig. 23.

Cypraea leucodon Broderip. Sowerby 1870, Thesaurus Conchyliorum. 4: (*Cypraea*), 13, pl. 295, figs. 19-20.

Cypraea leucodon Broderip. Tryon 1885, Manual of Conchology. (1) 7: 181, pl. 12, figs. 69-70.

Cypraea leucodon Broderip. Hidalgo 1907, *Mem. R. Acad.* Mad. 25: 396.

Callistocypraea leucodon (Broderip). Schilder and Schilder 1938, *Proc. malac. Soc. Lond.* 23: 177.

Mystaponda leucodon (Broderip). Allan 1956, Cowrie shells of world seas. (Georgian House: Melbourne), 8, 108, pl. 11, figs. 1-2.

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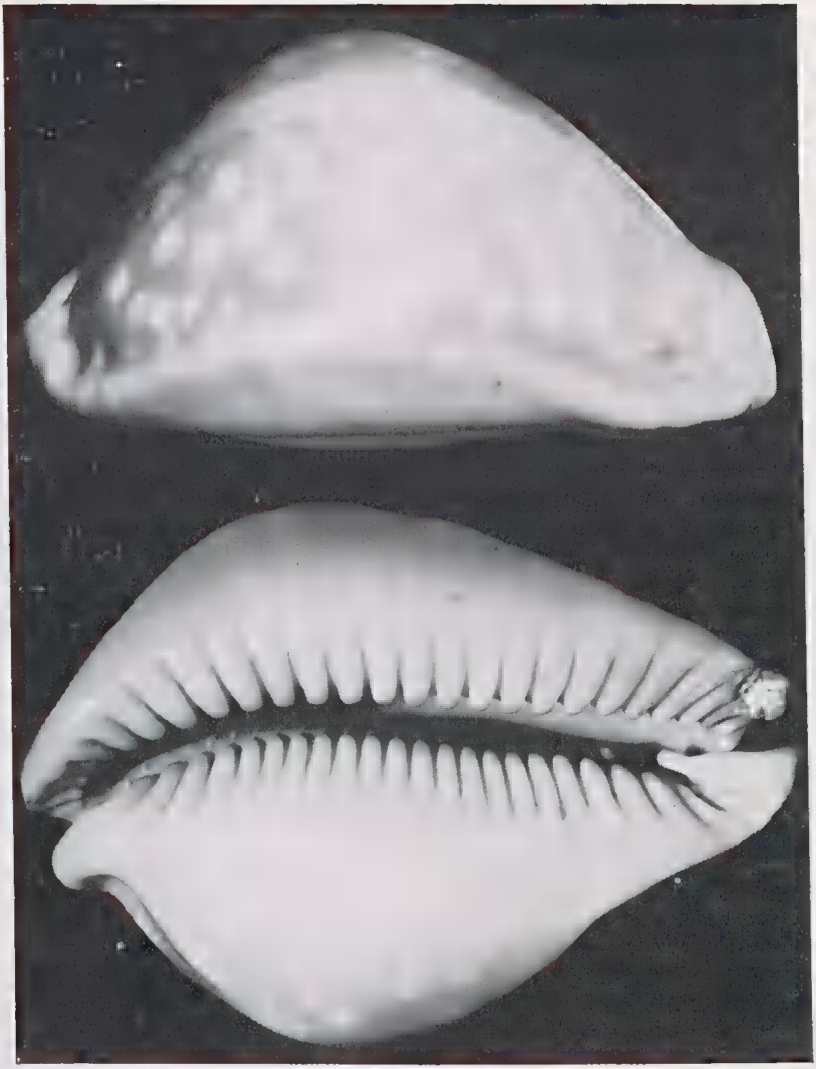

PLATE 2.

Cypraea leucodon Broderip, 1828.

Museum of Comparative Zoology, Harvard University. No. 38370. 1.24 X.

Length	Height	Width
77.5 mm.	43 mm.	54.5 mm.

The colouration of this specimen is very similar to that of the original figure of Broderip.

THE LIFE HISTORIES OF MARINE PROSOBRANCH GASTROPODS

By D. T. ANDERSON, Ph.D.*

INTRODUCTION.

The Australian littoral, especially along its more northerly reaches, displays a diversity and richness of life equal to that of any part of the world. It is still true to say, however, that very little is known of the biology of Australian shore animals. Almost every common species presents problems of numbers, distribution, habits of life and ecological relationships, as well as of such less fashionable matters as comparative anatomy and physiology, each of which calls for intensive treatment if we are to have a full understanding of this conspicuous and colourful component of Australia's natural fauna. The present article calls attention to a small aspect of this vast and complex challenge to our curiosity, a field more neglected than most, and yet among the easiest to gain new information about, life history studies of the littoral representatives of the prosobranch gastropod molluscs.

A full understanding of the opportunities and the scope of the problems in this field demands that account be taken of the present state of our knowledge of prosobranch life histories. Numerous scientific papers have been contributed on the subject by many authors, dating back as far as the middle of the last century, but examination of them, while it yields much that increases our understanding, reveals two important facts. Firstly, it is clear that the numbers of prosobranch species whose life histories are known is greatly exceeded by the number unknown. Generalizations are thus accepted whose factual basis is knowledge of but a fraction of classified genera and species. Secondly, students of prosobranch life histories have made their observations almost exclusively on European and North American species. The species of the southern continents, including Australia, are for the most part different even within families represented in common in both hemispheres, while the southern shores offer further for study numerous tropical and sub-tropical species belonging to families whose life history patterns we know not at all. Since no true picture of any aspect of biology can be gained without encompassing reference to its entire range of manifestation, the significance of this gap in knowledge is plain.

The information that we require of these species can be simply outlined. Onset and duration of the breeding season, the number of fertilized eggs produced by each female, the manner in which the eggs are laid and the nature of the spawn in species where they are not shed freely into the water, details of egg size and yolkiness, the duration of early development and the stage at which the embryo becomes a free-living feeding larva, the form of the larva and its detailed behaviour, the transformation of larva into adult at metamorphosis and the degree to which reorganization takes place, the mortality at each phase of development and the colonisation of the adult habitat by new individuals are all matters which have several kinds of significance. They are an essential part of the record of the natural history of one of Australia's most characteristic groups of animals; a prerequisite to understanding the

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evolution of the prosobranchs; and a basis for analysing ecological relationships among these animals, which cannot be done satisfactorily without knowledge of the mode of maintenance and increase of their populations and the factors which might bring about population movements and limit numbers and geographical range.

It is unfortunate for the intending worker in this field of study, open as much to the amateur as to the professional marine zoologist, that the numerous papers referred to above are scattered through a large number of scientific journals. Furthermore, although the more comprehensive of them review in some detail certain aspects of prosobranch life histories, there is no easily accessible source of reference to contemporary knowledge of the subject such as would quickly guide those wishing to further this knowledge through interest in their own local fauna. It is to fulfil such a need and to juxtapose the known and unknown in terms of specifically Australian opportunities that the present article has been prepared.

A BRIEF SUMMARY OF PRESENT KNOWLEDGE.

The majority of littoral prosobranchs are, of course, dioecious, although hermaphroditism has been occasionally recorded, particularly in *Crepidula fornicata* (Calyptraeidae; Conklin 1897, Orton 1909, 1922, Ankel 1935, 1936, Lebour 1937, Werner 1955). The anatomical differences which allow the prosobranchs to be separated into three systematic orders, the Archaeogastropoda, Mesogastropoda and Neogastropoda*, however, are accompanied by differences in their modes of breeding. Copulation is rare in archaeogastropods except in the Neritidae, the family most closely related to the mesogastropods. Eggs and sperm are either shed freely in large numbers into the water (Text fig. A; Fissurellidae, Haliotidae, Acmaeidae, Patellidae, some Trochidae) or deposited in groups embedded in a simple gelatinous matrix (Text fig. B; other Trochidae, Neritidae). Since in trochids which produce such jelly masses fertilization is external, a form of pseudocopulation involving association in pairs or groups, male and female together, must accompany spawning. Most archaeogastropods produce small microlecithal eggs, 60-100 μ in diameter, which develop rapidly into free-swimming trochophore larvae (Text fig. C) feeding on planktonic micro-organisms. Development of the free swimming larva quickly proceeds to shell formation, 180° torsion and the attainment of the basic prosobranch organization, with head, foot and visceral hump clearly outlined, the foot bearing a thin operculum, the visceral hump being covered by the already spirally coiled shell (Text fig. D). The prototroch of the trochophore becomes greatly enlarged to form the velum, the main propulsive organ of the now completed veliger larva. As planktotrophic life continues, the veliger enlarges and adds further to its shell. Within a short time metamorphosis ensues, the velum is either cast off or resorbed, and the veliger sinks to the bottom and assumes the crawling mode of life of the adult. Successful adoption of the latter depends on settlement on a suitable substratum, but little is yet known of the factors which influence or prevent settling in any species.

Some trochids, neritids and patellids produce larger eggs containing a greater volume of yolk. Here the trochophore organs are largely suppressed and the embryo either becomes free swimming as a lecithotrophic trochophore or remains within the jelly in which it is spawned. In the former case pelagic life is of very short duration, its significance being

*Following the classification adopted by Morton (1959).

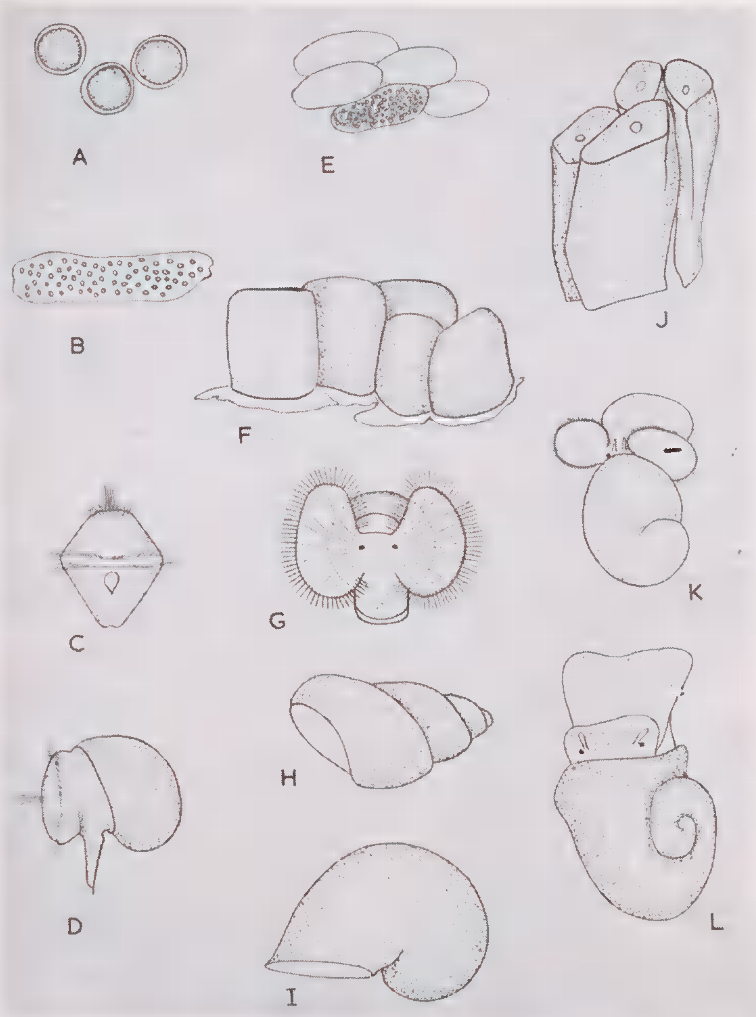
mainly distributive, and settling follows the initial transformation into a veliger with a simple velum, metamorphosis proceeding gradually once the adult habitat is attained. Where such large eggs are spawned in jelly, hatching from the jelly is generally delayed until the completion of metamorphosis, when the embryo emerges as a fully formed crawling miniature adult. One species of acmaeid, *Acmaea rubella,* becomes free at this stage after developing within the maternal oviduct. This is the only known case of viviparity among the archaeogastropods.

The course of development from the egg through to the smallest adult stage may vary between species of a single family, even between species of a single genus, a matter referred to by Coe (1949). The importance of such variations in assisting a taxonomic distinction between closely related species whose adults are almost indistinguishable is being increasingly recognized for marine invertebrates, but does not yet appear to have been exploited in prosobranch systematics save by Anderson (1958), who separates species of *Bembicium* on the basis of differences in their egg masses. Moreover, comparative studies of mode of deposition of the eggs (establishing the environment of early development), egg size and yolkiness, the related degree of development of larval ciliation, speed of development and what might be called the retentiveness of the gelatinous spawn where present (some prosobranch egg masses offer more obstacles to escape of the embryos than others) have received little attention in prosobranchs, although it is obvious that they form an interrelated complex whose total effect broadly determines the life history patterns of species.

Among the mesogastropods, the much larger number of families is associated with a similarly greater diversity of life-history patterns. All of them, however, appear to be derived from the basic pattern of the primitive archaeogastropods.

All mesogastropods show copulation. Subsequently, the female produces eggs that are always yolky and deposited almost always in a cocoon. In the more primitive species this may be simply a gelatinous matrix, as in the archaeogastropods, or a group of such jelly masses together (Text fig. E). The trochophore stage is largely suppressed and passed within the jelly of the cocoon, so that hatching occurs at the earliest as a veliger (Text fig. G). This may be either active planktotrophic (Text fig H), with a long planktonic life, or lecithotrophic, with a short planktonic life (Text fig. I). In the former a well-developed spiral shell of several whorls is formed during growth of the veliger in the plankton; in the latter, the shell is characteristically bulbous and shows little sign of spiral growth before metamorphosis. Metamorphosis is usually a rapid process in the planktotrophic veliger, settling as a miniature adult following it directly, but in the lecithotrotrophic veliger it proceeds gradually after settling has taken place. The same problems of larval settlement and the conditions which influence it exist in the mesogastropods as in the archaeogastropods, as do those of the relationship between mode of spawning, egg size, ciliation, etc. and pattern of the life history.

Great variation occurs in the egg cocoons. In a very few primitive species no cocoon of any kind is produced, the eggs being simply shed freely into the water. Most species produce jelly masses, but there are many which elaborate on this, laying a series of capsules each with a tough outer wall and internal jelly in which the eggs are embedded



Text figure. (Diagrammatic).

A. Archaeogastropod eggs.
B. Archaeogastropod jelly mass.
C. Archaeogastropod trochophore.
D. Archaeogastropod veliger.
E. Primitive mesogastropod jelly mass (*Bembicium*).
F. Advanced mesogastropod egg capsules (*Mayena*).
G. Mesogastropod early veliger.
H. Shell of planktotrophic late mesogastropod veliger.
I. Shell of lecithotrophic late mesogastropod veliger.
J. Neogastropod egg capsules (*Dicathais*).
K. Encapsulated neogastropod veliger.
L. Neogastropod crawling hatching stage.

(Text fig. F); while the capsules themselves may be deposited in a group of characteristic overall shape. Others lay a tough jelly string with a series of fluid-filled spaces inside, the eggs floating in the fluid, which appears to be a nutritive albuminous substance. In a few species, only one or two of the eggs in each space develop, the others forming nurse eggs which are utilized as food by the developing veligers. These more elaborate provisions for protection and ensured food supply are generally accompanied by suppression of the normal trochophore-veliger temporary organs, more direct development to hatching as a crawling miniature adult, and occasionally the precocious development of the adult feeding apparatus as a means to utilizing available food. Hatching from the spawn is greatly delayed in such species. There appears also to be a correlation between the length of planktonic veliger life and the number of eggs spawned by the female. Species with a long-lived planktotrophic veliger produce eggs in very large numbers: those whose development is direct generally produce many less eggs. A very few species of mesogastropod are ovoviviparous, retaining their eggs within a brood chamber, a specialized part of the oviduct, until their development is completed and they are born as young adults. The European *Littorina saxatilis* is one such species. In fact a clear adaptive relationship between life history pattern and distribution on the shore is seen for the European littorinids, which exhibit a zonation as marked as that of the *Bembicium—Melaraphe—Nodilittorina* zonation of the Australian coast.

L. littorea: lower littoral—eggs laid in floating jelly masses, long planktonic life.

L. obtusata: mid-littoral—eggs laid in jelly masses, hatch crawling.

L. saxatilis: upper littoral—ovoviviparous, born crawling.

L. neritoides: upper littoral—eggs released freely into sea, long planktonic life.

The exceptional life history of *L. neritoides*, which although it is highest on the shore of all these species, shows no obvious adaptation to breeding in such a situation, only emphasises how difficult it is to make generalizations about prosobranch life histories and how great is the need for further information. We do not yet know if comparable adaptations are to be found among the Australian species.

As with the archaeogastropods, the pattern of the life history in mesogastropods may vary within families, even within genera, from the extremes of long pelagic planktotrophic life to direct adoption of the benthic crawling habit. The wide variation that is possible within a single genus is clearly displayed by the example of the littorinids mentioned above. No mesogastropod, however, hatches before the veliger stage.

The neogastropods in general resemble the most specialized of the mesogastropods in their life histories. All of them lay eggs in tough capsules filled with gelatinous fluid (Text fig. J). The eggs may be relatively small, with escape taking place at the veliger stage to a long pelagic planktotrophic life, but usually the eggs are large and yolky, hatching is delayed and pelagic life is either very short or omitted (Text figs. K, L). In some species development within the capsules may take several weeks, hatching occurring as a relatively large juvenile. Nurse eggs are characteristic of certain families of neogastropods, and almost all species provide an albuminous nutriment for the encapsulated

embryos. The problems of relation between mode of oviposition and mode of development, of larval settlement and distribution, etc., are as obvious for the neogastropods as for other prosobranchs, while generic and familial variation again need further detailed study.

In general it can be said that the archaeogastropods tend towards a short pelagic life, the mesogastropods towards a long pelagic life, while in most neogastropods the pelagic phase is omitted. The mesogastropods are thus perhaps the most difficult subjects for life history studies, since even if their egg masses can be found and identified, their planktotrophic veligers are very sensitive to culture conditions, and usually die after a few days. However, in such circumstances a fairly accurate estimate can be made of whether or not the type of veliger under consideration is an important constituent of the plankton by examining:

(a) The numbers of eggs hatching as veligers, which should be high.
(b) The ciliary feeding mechanism of the veliger, which should be conspicuous and elaborate.
(c) The veliger shell, which should be well developed and spirally coiled.
(d) The absence of yolk from the visceral hump and advanced differentiation of the internal organs.

It has been demonstrated from a number of studies of prosobranch life histories that in the colder regions of the northern hemisphere planktonic larvae are either absent or exceptional, but that they become more common among species of the temperate zone, and are almost exclusive among tropical species. Such studies, however, may not reflect the position of the Australian fauna, since they have not included numerous species of neogastropod such as are characteristic in this country. Only detailed investigation of our many unique species can determine whether or not the tentative conclusions that have emerged from studies in the northern hemisphere can be applied without qualification to the Australian littoral prosobranchs.

AN APPROACH TO THE PROBLEM.

Familiarity with the general pattern of life histories to be expected among our littoral prosobranchs, together with a synoptic view of the many aspects of a life history relevant to a complete picture, provide a starting point for the investigation of individual local species. In order to indicate those which would repay study, a summary is given below of the littoral genera which have species commonly represented along various parts of the Australian coast, together with such information as we have about their life histories; and for comparison, species of the same families whose life histories are known, with references to their description, are listed. Of the latter, only species for which a reasonably full account is available are mentioned, and only the important references given for each. These will lead the interested reader to other references and to the few other species of which we have fragmentary knowledge. It is also essential to take account in studies of this kind of the work of Lebour (1937) and Thorson (1946, 1950), whose summaries of the life histories of the prosobranchs of distinct faunal areas, namely, the British prosobranchs and the Danish Baltic prosobranchs, are the only comprehensive accounts of their kind available.

(1) Order *ARCHAEOGASTROPODA.*

Fissurellidae. — Only for one species of this interesting primitive family, *Diodora apertura,* is the life history known (Boutan, 1885), and this species is unusual among primitive archaeogastropods in spawning its eggs in a jelly mass from which the young hatch crawling. Species of *Tugali, Emarginula, Montfortula, Scutus, Elegidion,* etc., would no doubt provide a much broader picture of the life histories of the family.

Haliotidae. — One European species of haliotid, *Haliotis tuberculata,* has been intensively studied (Crofts, 1937, 1955), and one Japanese species, *Haliotis gigantea,* in less detail (Murayama, 1935). Both shed their eggs freely into the water and have a planktotrophic trochophore and veliger. We do not yet know whether this is also true of the Australian species of *Haliotis, Notohaliotis* and *Gena.*

Trochidae. — While three northern hemisphere species of trochid, *Gibbula magnus, G. cineraria* and *G. umbilicalis,* shed their eggs freely and have planktotrophic trochophores and veligers (Robert 1902), all other described species deposit their eggs in jelly and hatch at the crawling stage (*Gibbula tumida* (Gersch 1936), *Calliostoma ziziphynum* and *C. papillosum* (Lebour 1936, Crofts 1955), *Margarites helicinus* (Thorson 1935), *Cantharidus* (= *Trochus*) *exasperatus* and *C.* (= *Trochus*) *striata* (Robert 1902)). Study of the many Australian species included in the genera *Austrocochlea, Trochus, Clanculus, Thaliota,* etc. would greatly extend our knowledge of trochid life histories. *Trochus niloticus* is reported by Moorhouse (1932) to shed its eggs freely in the primitive manner.

Turbinidae. — Nothing appears to be known of turbinid life histories save that the British species *Tricolia pullus* sheds its eggs freely into the water (Lebour 1937). The many common species of Australian genera such as *Turbo, Ninella, Subninella* and *Bellastrea* could serve to establish the typical life history patterns of the family.

Acmaeidae. — The few known species of acmaeid show a wide range of life history patterns. *Patelloida virginea* sheds its eggs freely and has planktotrophic trochophores and veligers (Boutan 1898, 1899). *Patelloida tessulata* (= *Acmaea testudinalis*) lays its eggs in jelly, from which the embryos hatch as pelagic veligers (Wilcox 1905). *Acmaea rubella,* an arctic species, is viviparous (Thorson 1935; see p. 18). Presumably the Australian species of *Notoacmaea, Patelloida,* etc., fit within this pattern, but we do not yet know where.

Patellidae. — All patellids so far studied shed their eggs freely and have planktotrophic trochophores and veliger larvae (*Patella vulgata* (Dodd 1957, Crofts 1955, Smith 1935), *Patella cerulea* (Patton 1886, Lo Bianco 1899), *Patina pellucida* (Crofts 1955, Lebour 1937, Smith 1935)). Artificial fertilization appears to lead to successful culture in this family and could be employed for local species of *Cellana, Patellanax,* etc.

Neritidae. — All neritids so far studied, unlike other archaeogastropods, deposit their eggs in dome-shaped hard capsules. Hatching generally takes place at the crawling stage (*Nerita albicella, N. reticulata,* Risbec 1932) after a long period of development, though in three species of *Nerita* from Bermuda Lebour (1945) suggests that there may be a pelagic phase in the life history. A brackish water species, *Neritina*

fluviatilis, is unusual in having nurse eggs within the capsule, with only a single embryo hatching (Bondensen 1940). Nothing is known of Australian neritid life histories save that the very common *Melanerita melanotragus* produces typical neritid egg capsules (Hedley 1916, 1923).

(2) Order *MESOGASTROPODA.*

Littorinidae. — Reference has already been made (p. 20) to the wide variety of life history patterns shown by the littorinids and to their partial adaptation to environment. The details that have been obtained for northern hemisphere species are summarised below:

(a) Eggs laid singly in floating capsules, hatching as planktotrophic veligers:

Littorina littorea—lower littoral: Hayes (1929), Linke (1934), Lebour (1937), Moore (1937).

L. neritoides—supra-littoral fringe: Lebour (1935b).

L. zigzag, *Tectarius muricatus*, *Echinella trochiformis* — Lebour (1945).

(b) Eggs laid in jelly, hatching as planktotrophic veligers.

Lacuna divaricata: Hertling and Ankel (1927). Hertling (1928, 1931), Lebour (1937).

(c) Eggs laid in jelly, hatching at crawling stage.

Littorina obtusata—mid-littoral: Pelseneer (1911), Delsman (1914), Linke (1934).

Lacuna pallidula: Hertling and Ankel (1927), Lebour (1937), Gallien and Larambergue (1938).

(d) Ovoviviparous, young born as planktotrophic veligers.

Littorina angulifera—supra-littoral, mangrove swamps: Lebour (1945).

(e) Ovoviviparous, young born at crawling stage.

L. saxatilis—upper littoral: Pelseneer (1911), Delsman (1914), Linke (1934).

As already pointed out (p. 20), we do not yet know whether the Australian littorinids show corresponding adaptations of the life history to environment, an especially interesting case being the *Bembicium, Melaraphe, Nodilittorina* zonation familiar to all students of rock platform prosobranchs. This group of animals calls for close attention.

Planaxidae. — Nothing is known of planaxid life histories. Species of several local genera, notably *Hinea* and *Planaxis,* could easily be studied.

Rissoidae. — Lebour (1937) points out that the numerous species of small snails included in the Rissoidae probably make an important contribution to the plankton of British waters, and the same may be true of Australian waters, since many rissoid species abound along our coasts. Again, however, we know nothing of their life histories, and indeed only a few are known within the entire family. They characteristically produce oval, tough, thick-walled egg capsules, each containing a small number of eggs (*Onoba semicostata, Alvania punctura, Rissoa sarsi, R. inconspicua,* Lebour (1934a, 1935, 1937)). The three last named species hatch as planktotrophic veligers: the first hatches at the crawling stage.

Cerithiidae. — The opportunity to extend our knowledge of the life histories of cerithiid prosobranchs lies with the coral reef genera of the north, notably *Cerithium*. The need for such study is shown by the fact that only two cerithiids have been briefly examined so far, the Haiwaian *Clava obeliscus* (Ostergaard 1950) and the Bermudan *Cerithium ferruginum* (Lebour 1945), both of which lay long coiled gelatinous egg strings from which hatch planktotrophic veligers.

Potamididae. — Of this family, closely related to the cerithiids, we have even less knowledge. Only one species, *Bittium reticulatum*, has been adequately studied (Lebour 1936) and found to lay its eggs in a jelly mass from which again hatch planktotrophic veligers. The very common *Pyrazus* and *Bittium* species of Australia could thus be studied to advantage.

Turritellidae. — The turritellids again are almost unknown. Only the life history of *Turitella communis* has been recorded (Lebour 1933a), its eggs being laid in a jelly mass from which lecithotrophic veligers with a short pelagic life emerge. The common turritellids of Australia, e.g., *Turritella* and *Gazameda* species, have not been examined.

Scalidae. — The life histories of two species of *Scala* are known (Vestergaard 1935, Lebour 1937), their eggs being laid in small capsules and probably hatching as planktotrophic veligers. Further, one of these species, *S. clathrus*, is reported to be a protandrous hermaphrodite (Ankel 1936, 1938). Although they are not especially common as Australian littoral forms, scalid species do occur, and may well provide interesting additions to this fragmentary story.

Strombidae. — Like the cerithiids, strombs are characteristic reef animals, yet we know little of their life histories. Ostergaard (1950) and Risbec (1932) report that *Strombus maculatus*, *S. rugosus* and *Lambis* (=*Pterocera*) *lambis* all lay long, fine, coiled gelatinous egg strings, somewhat like those of opisthobranchs, and that the eggs of *S. rugosus* hatch as pelagic veligers. The Australian reef species have not been studied.

Naticidae. — All naticids appear to produce a characteristic spawn, a cylindrical ribbon of jelly covered externally by sand grains and having inside large individual egg spaces filled with nutritive albumen. The life histories of three northern hemisphere species have been studied, and show a wide range of variation. *Natica nitida* (Hertling 1932, Lebour 1937) hatches as a planktotrophic veliger, *N. pallida* (Thorson 1935) hatches at the crawling stage and *N. catena* (Ankel 1930), (Hertling 1932) hatches again at the crawling stage after a long period during which it feeds on nurse eggs. How far the life histories of Australian species of *Conuber* (=*Uber*), *Natica* and *Mamilla* correspond to any of these types is unknown.

Cypraeidae. — Although the cypraeids are among the best known of Pacific prosobranchs, astonishingly little is known of their life histories and nothing at all for Australian species. Ostergaard (1950) describes the early stages of five Haiwaian species of *Cypraea*, all of which lay numerous small horny capsules from which hatch planktotrophic veligers, and records instances of brood protection on the part of the females. Lebour (1932) describes similar capsules and veligers for *Simnia patula* and (1937) mentions that brood protection and small horny capsules are typical of the family.

Lamellariidae. — Only a few lamellariid species are recorded for Australia, and little is known of them, but any of them would repay further examination as to their life histories, for such information as we have on this family shows it to have a unique pattern of development involving planktotrophic veligers characterised by an additional larval shell, presumably flotatory in function, known as echinospiras. Furthermore, the eggs are laid in capsules within holes bored in the tests of compound ascidians by the spawning female. Such a life history pattern has been recorded for *Lamellaria conspicua* (Ankel 1935, Lebour 1935a) and *Trivia europea* (Pelseneer 1926, Lebour 1931b), and is probably followed by *Velutina velutina* (Lebour 1935, 1937).

Cassidae. — Nothing is known of cassid life histories. As with cerithiids, the common Australian species of *Cassia, Xenogalea* and *Phallium*, etc., provide a unique opportunity to fill this gap.

Cymatiidae. — Many well-known species of symatid occur on the Australian coast, belonging to such genera as *Charonia, Monoplex, Cymatilesta* and *Mayena*. The life history of *Cymatilesta spengleri* has been described (Anderson 1959), the eggs being laid in an elaborate group of capsules from which hatching occurs at the crawling stage; but no other life history within the family is known. Variations in the life history patterns of different species must be considerable, however, and deserve further study, since Lebour (1945) records planktotrophic veligers for two species of *Cymatium* from Bermuda.

(3) Order *NEOGASTROPODA*.

Buccinidae. — Life histories are recorded for three species of buccinid, *Pallia tincta* (Lebour 1945), *Sipho sp.* (Thorson 1935) and *Buccinum undatum* (Portmann 1925, 1926, 1927, 1930, Lebour 1937). All lay their eggs in tough capsules and are typified by many nurse eggs and the hatching of a few young at the crawling stage. It would be interesting to know whether the Australian species of *Cantharus, Cominella*, etc., confirm this as the typical pattern.

Nassariidae. — Like the buccinids, the nassariids appear to show a single life history pattern characteristic of the family, producing horny, tough, bottle shaped capsules from which the young hatch as planktotrophic veligers. This has been found for *Nassarius reticulatus* (Pelseneer 1911, Ankel 1929, Lebour 1931a, 1937), *N. pygmaeus* (Vestergaard 1935) and *N. incrassatus* (Lebour 1931a). We do not yet know if it is true for Australian species of *Nassarius, Parcanassa*, etc.

Fasciolariidae. — Very little is known of fasciolariid life histories. Portmann (1955) provides a little on *Fusus*, while Allen (1950) briefly refers to the Australian species *Pleuropoca australasia*, which lays its eggs in bell-shaped capsules from which the young, after a cannibalistic existence, hatch at the crawling stage. We need to know much more of species of such genera as *Colus* and *Peristemia*.

Galeolidae. — One of the largest of all prosobranchs, *Megalotractus aruanus*, graces the Australian shore as a member of this family. Allen (1950) describes the complex egg capsules of this species, from which the young hatch at the crawling stage, but we do not yet know the details of its development or of that of any other galeolid save *Fulgur*, described by Conklin (1907), with a life history pattern similar to that of *Megalotractus*.

Muricidae. — The life histories of several species of muricid have been described. All lay their eggs in vase-shaped capsules, from which the young hatch at the crawling stage (*Trophon muricatus* (Lebour 1936), *T. clathratus* (Thorson 1940), *Murex blainvillei* (Franc 1948), *Urosalpinx cinerea* (Lebour 1937), *Nucella lapillus* (Pelseneer 1911, Portmann 1925, 1926, 1930, Lebour 1937), *Neptunea antiqua* (Thorson 1935, 1941)), while in the two last-named species the young consume numerous nurse eggs before hatching. *Bedeva* (= *Trophon*) *hanleyi* is the only Australian species whose life history is known (Hedley 1916), and it resembles those species above which lack nurse eggs. Much remains to be learnt of species of *Chicoreus, Acupurpura, Murex, Agnewia,* etc., on Australian shores.

Mitridae. — Species of mitre shell remain common yet unstudied, in such genera as *Vexillum, Strigatella* and *Vicimitra.* The only information on life histories in this family is provided by Ostergaard (1950), who states for *Mitra astricta* and *M. auriculoides* that the eggs are laid in vase-shaped capsules and the young hatch as late veligers, probably briefly pelagic.

Conidae. — The many species of cone common on Australian shores again have unknown life histories. A few species have been briefly studied in other countries by Ostergaard (1950), Lebour (1945), Thorson (1940) and Risbec (1932). All lay their eggs in flattened egg pouches, but while the majority hatch as planktotrophic veligers, at least one species, *Conus omaria,* hatches at the crawling stage.

Turridae. — In this family, as in the cones and mitres, many species occur and none have been studied. We have some information from the work of Vestergaard (1935) and Thorson (1935) to show that some species of *Bela* hatch crawling, while Lebour (1933b, 1934b, 1937) has shown that species of *Philbertea* and *Mangelia* have planktotrophic veligers. Eggs always appear to be laid in lens-shaped capsules.

Volutidae. — Volutes are numerous on Australian shores, and in other parts of the world, yet only one species has been investigated as to its life history. This is the well-known Australian Baler shell, *Melo umbilicata,* which is described by Allen and Middleton (1946) as producing a complex mass of egg capsules from which the young hatch crawling at a late stage of development. As with the cones and so many other families, there are numerous problems of distribution and systematics in the volutes which require as an aid to their solution a detailed knowledge of life histories.

For the rest, the Thaididae (*Mancinella, Dicathais, Morula,* etc.), Magilidae (*Rapa, Magilus,* etc.), Harpidae (*Harpa,* etc.), Oliviidae (*Oliva* spp.), Marginellidae (*Marginella* spp.) and Terebridae (*Terebra,* etc.), not only is there no recorded knowledge of the life histories of Australian species, but there is no information as to the life history patterns of any species. Among these completely unknown families and among those for which we have an amount of information that, as shown above, is small at best, the problems outlined in the introduction stand out strikingly. No one worker can possibly solve them all. It can only be hoped that all those whose interests lie among molluscs will see fit to add where they can to this fascinating and biologically important story.

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REFERENCES.

ALLAN, J., 1950. Australian Shells (Georgian House, Melbourne).

ALLAN, J., and MIDDLETON, T. C., 1946. Observations on the egg case and young of the Baler Shell, *Melo umbilicata* Brod. . *Vict. Nat.*, 62: 172-177.

ANDERSON, D. T., 1959. The reproduction and early life history of the gastropod *Cymatilesta spengleri* (Perry) (Fam. Cymatidae). *Proc. Linn. Soc. N.S.W.* 84: 232-237.

ANDERSON, H., 1958. The gastropod genus *Bembecium* Phillipi. *Aust. J. Mar. Freshw. Res.*, 9: 546-568.

ANKEL, W. E., 1929. Über die Bildung der Eikapsel bei Nassa-Arten. *Zool. Anz.* Suppl. 4: 219-230.

————, 1930. Nähreierbildung bei *Natica catena* (da Costa). *Ibid.*, 89: 129-135.

————, 1935. Das Gelege von *Lamellaria perspicua* L., *Z. Morph. Ökol. Tiere,* 30: 635-647.

————, 1936. Prosobranchia, in: *Tierwelt N.-u-Ostsee.*, 9b: 1-240.

————, 1938. Beobachtungen an Prosobranchiern der Schwedischen Westküste. *Ark. Zool.*, 30A: 1-27.

BONDENSEN, P., 1940. Preliminary investigations into the development of *Neritina fluviatilis* L. in brackish and fresh water. *Vidensk. Medd. Dansk Naturh. Foren.*, 104: 283-317.

BOUTAN, L., 1885. Recherches sur l'anatomie et le développement de la Fissurelle. *Arch. Zool. exp. gén. Ser.* 2, 3: 1-173.

————, 1898. Sur le développement de *l'Acmaea virgininea. C.R. Acad. Sci. Paris,* 126: 1877-1879.

————, 1899. La cause principale de l'asymetrie des mollusques gastéropodes. *Arch. Zool. exp. gén. Ser.* 3, 7: 203-342.

COE, W. R., 1949. Divergent methods of development in morphologically similar species of gastropod prosobranch. *J. Morph.*, 84: 383.

CONKLIN, E. G., 1897. The embryology of *Crepidula.* A contribution to the cell lineage and early development of some marine gastropods. *J. Morph.*, 13: 1-226.

————, 1907. The embryology of *Fulgur.* A study of the influence of yolk on development. *Proc. Acad. nat. Sci. Philad.*, 59: 320-359.

CROFTS, D. R., 1937. The development of *Haliotis tuberculata,* with special reference to organogenesis during torsion. *Phil. Trans. Roy. Soc. Lond.* B, 228: 219.

————, 1955. Muscle morphogenesis in primitive gastropods and its relation to torsion. *Proc. zool Soc. London,* 125: 711-750.

DELSMAN, H. C., 1914. Entwicklungsgeschichte von *Littorina obtusata. Tijdschr. ned. dierk. Ver.*, 13: 170-340.

DODD, J. M., 1957. Artificial fertilization, larval development and metamorphosis in *Patella. Pubbl. Staz. zool. Napoli,* 29: 172-136.

FRANC, A., 1948. Sur la ponte et le développement de *Murex blainvillei* Payr. *J. Conchyliol.*, 88: 10-12.

GALLIEN, L., and LARAMBERGUE, M., 1938. Biologie et sexualité de *Lacuna pallidula* Da Costa (Littorinidae). *Trav. Sta. zool. Wimereux,* 13: 293-306.

GERSCH, M., 1936. Die Genitalapparat und die Sexualbiologie der Nordseetrochiden. Z. *Morph. Ökol. Tiere,* 31: 106-150.

HAYES, F. R., 1929. Contribution to the study of marine gastropods. III. Development, growth and behaviour of *Littorina*. *Contr. Canad. Biol. Toronto, N.S.*, 4: 413-430.

HEDLEY, C., 1916. Studies on Australian Mollusca. Part XIII. *Proc. Linn. Soc. N.S.W.*, 41: 680-719.

————, 1923. Studies on Australian Mollusca. Part XIV. *Ibid.*, 48: 301-316.

HERTLING, H., 1928. Beobachtung und Versuche an den Eiern von *Littorina* und *Lacuna*. Bedeutung der Eihüllen. *Wiss. Meeresuntersuch. Abt. Helgol.*, 17: 49 pp.

————, 1931. Über den Einfluss des veranderten Mediums auf die Entwicklung von *Lacuna divaricata*, besonders auf die Bildung der Schale. *Ibid.*, 18: 1-27.

————, 1932. Zur Kenntnis des Laichbandes und der Veligerlarven von *Natica pulchella* Risso. *Zool. Anz.*, 100: 95-100.

HERTLING, H., and ANKEL, W. E., 1927. Bemerkungen uber Laich und Jugendformen von *Littorina* und *Lacuma*. *Wiss Meeresuntersuch. Abt. Helgol.*, 16: 13 pp.

LEBOUR, M. V., 1931a. The larval stages of *Nassarius reticulatus* and *Nassarius incrassatus*. *J. Mar. biol. Ass. U.K.*, 17: 797-818.

————, 1931b. The larval stages of *Trivia europea*. *Ibid.*, 17: 819-832.

————, 1932. The larval stages of *Simnia patula*. *Ibid.*, 18: 107-115.

————, 1933a. The eggs and larvae of *Turritella communis* Lamarck and *Aporrhais pespelicani* (L.). *Ibid.*, 18: 499-506.

————, 1933b. The eggs and larvae of *Philbertia gracilis* (Montagu). *Ibid.*, 18: 507-510.

————, 1934a. Rissoid larvae as the food of young herrings. The eggs and larvae of the Plymouth Rissoidae. *Ibid.*, 19: 523-539.

————, 1934b. The eggs and larvae of some British Turridae. *Ibid.*, 21: 541-554.

————, 1935a. The echinospira larvae of Plymouth. *Proc. zool. Soc. Lond.*, 1935: 163-174.

————, 1935b. The breeding of *Littorina neritoides*. *Jour. Mar. biol. Ass. U.K.*, 20: 373-378.

————, 1936. Notes on the eggs and larvae of some Plymouth prosobranchs. *Ibid.*, 20: 547-565.

————, 1937. The eggs and larvae of the British prosobranchs, with special reference to those living in the plankton. *Ibid.*, 22: 105-166.

————, 1945 The eggs and larvae of some prosobranchs from Bermuda. *Proc. zool. Soc. Lond.*, 114: 462-489.

LINKE, O., 1934. Beiträge zur Sexualbiologie der Littorinen. Z. *Morph. Ökol. Tiere,* 28: 170-177.

LO BIANCO, S., 1899. Notizie biologiche riguardente specialmente il periodo di maturita sessuale degli animale de Golfo di Napoli. *Mitt. zool. Sta. Neapel,* 8: 385-440.

MOORE, H. B., 1937. The biology of *Littorina littorea*. Part I. Growth of the shell and tissues, spawning, length of life, mortality. *J. Mar. biol. Ass. U.K.*, 21: 721-742.

MOORHOUSE, F. W., 1932. Notes on *Trochus niloticus*. *Sci. Rep. Gr. Barrier Reef Exped.*, 3 (5): 145-155.

MORTON, J. E., 1959. "Molluscs". (Hutchinson: London.)

MURAYAMA, S., 1935. On the development of the Japanese Abalone, *Haliotis gigantea*. *J. Coll. Agric. Tokyo,* 13: 227-233.

ORTON, J. H., 1909. On the occurrence of protandric hermaphroditism in *Crepidula fornicata*. *Proc. Roy. Soc. Lond. B,* 81: 468-484.

———, 1922. The phenomena and conditions of sex-change in the oyster (*O. edulis*) and *Crepidula*. *Nature, Lond.,* 110: 212-214.

OSTERGAARD, J. M., 1950. Spawning and development of some Haiwaian marine gastropods. *Pacific Sci.,* 4: 75-115.

PATTEN, W., 1886. The embryology of *Patella*. *Arb. zool. Inst. Univ. Wien,* 6: 149-174.

PELSENEER, P., 1911. Recherches sur l'embryologie des Gastropodes. *Bull. Sci. Fr. Belg.,* 44: 1-167.

———, 1926. Notes d'embryologie malacalogique. Ponte et développement de *Cypraea europea, Triforis perversa* et *Lucina lactea*. *Ibid.,* 60: 88-112.

PORTMANN, A., 1925. Der Einfluss der Nähreier auf die Larven Entwicklung von *Buccinum* und *Purpura*. *Z. Morph. Ökol. Tiere,* 3: 526-541.

———, 1926. Le rôle spermatozoide atypique dans la formation des oeufs nourriciers de *Buccinum undatum* L. *Arch. Zool. exp. gén.,* 65: 103-124.

———, 1927. Die Nähreierbildung durch atypische Spermien bei *Buccinum undatum* L. *Zeitschr. Zellforsch.,* 5: 230-243.

———, 1930. Die Larveneieren von *Buccinum undatum* L. *Ibid.,* 10: 401-410.

———, 1955. La métamorphose "abritée" de *Fusus*. (Gast. Prosobranchs). *Rev. suisse Zool.,* 62: 236-252.

RISBEC, J., 1932. Notes sur la ponte et le développement de mollusques gasteropodes de Nouvelle—Caledonie. *Bull. Soc. zool. Fr.,* 57: 358-374.

ROBERT, A., 1902. Recherches sur le développement des Troques. *Arch. Zool. exp. gén., Ser.* 3, 10: 269-538.

SMITH, F. G. W., 1935. The development of *Patella vulgata*. *Phil. Trans. Roy. Soc. Lond.* B, 225: 95-125.

THORSON, G., 1935. Studies on the egg capsules and development of Arctic marine prosobranchs. *Medd. Grnland,* 100: 1-71.

———,1940. Studies on the egg masses and larval development of Gastropoda from the Iranian Gulf. *Danish Scientific Investigations in Iran,* Part 2: 159-238.

———, 1946. Reproduction and larval development of Danish marine bottom invertebrates. *Medd. Komm. Danmarks Fisk., ser. Plankton,* 4: 1-523.

———, 1950. Reproduction and larval ecology of marine bottom invertebrates. *Biol. Rev.,* 25: 1-45.

VESTERGAARD, K., 1935. Über den Laich und die Larven von *Scalaria communis* (Lam.), *Nassarius pygmaeus* (Lam.) und *Bela turricola* (Mont.) *Zool. Anz.,* 109: 217-222.

WERNER, B., 1955. Über die Anatomie, die Entwicklung und Biologie des Veligers und der Veliconcha von *Crepidula fornicata* L. *Helgoland, wiss. Meeresuntersuch* 5: 169-217.

WILLCOX, M. A., 1905. Biology of *Acmaea testudinalis* Müll. *Amer. Nat.,* 39: 325-333.

A NEW *MELIOBBA* FROM THE SCHRADER RANGE, NEW GUINEA

By W. J. CLENCH, Ph.D.* and R. D. TURNER, Ph.D.†

Through the kindness of Dr. D. F. McMichael, of the Australian Museum, Sydney, we received a new and unique specimen of *Meliobba*, a genus in the sub-family Papuininae.

Meliobba is a genus of wide distribution in New Guinea and in northern Queensland, Australia. Individual specimens of all species appear to be quite rare, judging by the very few specimens we have seen.

Genus *MELIOBBA* Iredale.

Meliobba Iredale, 1940, *Aust. Nat.*, 10: 240. Type species by monotypy, *Meliobba shafferyi* Iredale.

Meliobba helenae sp. nov.

Description: Shell reaching 40 mm. in greatest diameter, rather solid in structure, but thin, rimately perforate and finely sculptured. Whorls 4½, depressed, and having an exceedingly sharp peripheral keel. Colour a mottled gray and brown on the early whorls, changing to greenish gray on the body whorl; interior of shell a dark mahogany-brown. Spire depressed, obtuse and cast at an angle of 120°. Aperture ovate and produced at an angle of about 30° from the base of the shell. Parietal area glazed with dark mahogany-brown. Palatal lip white, thin and reflected. Columella short and somewhat broadened. Suture indistinct. Umbilicus nearly covered by the columella reflection. Sculpture both above and below the periphery consisting of numerous fine, axial ridges and growth lines which parallel the margin of the lip. The surface above the periphery near the aperture is slightly malleated. Nuclear whorls 2, the apex brownish and with fine recurved thread-like ridges emanating from the suture.

The upper surface of the foot is brownish-yellowish in colour; the sole is deep ivory, becoming yellow near the margin. The remainder of the body is dark brown. The tentacles, when fully extended, are very long, nearly black, with swollen yellow-brown tips and minute black eyes. The genital pore is at the base of the right tentacle, and is margined with yellow-brown.

Dimensions:	Height	Greater diameter	
	22.5 mm.	40 mm.	Holotype.

Types: The holotype is in the Australian Museum, No. C.62378, and is from Asai-Simbai Divide, Schrader Range, a few miles due west of Aiome, Territory of New Guinea (Aiome is at 05° 05′ S; 144° 50′ E) at 5000 feet, collected by R. Bulmer, February 24, 1960.

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†Research Associate, Department of Mollusks, Museum of Comparative Zoology, Cambridge, Mass.

Remarks: Meliobba helenae differs from all other species in this genus by having the sculpture composed of very fine axial threads and not the more or less spirally arranged, interlacing ridges that are characteristic of all other species. It also differs from all others by its exceedingly acute keel. Named for Mrs. Donald (Helen) McMichael.

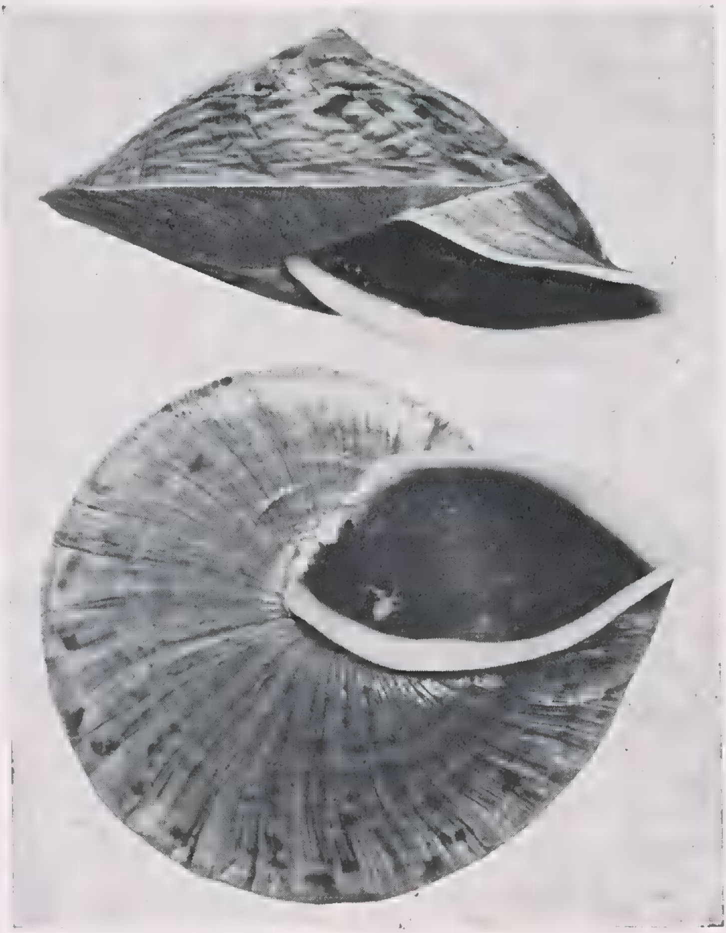

PLATE 3.

Meliobba helenae Clench and Turner. Holotype. Australian Museum, No. C.62378 (x 2).

A NOTE ON "*PETTANCYLUS*" *AUSTRALICUS* (Tate).

By BENGT HUBENDICK, D.Sc.*

Some years ago, Miss L. M. Angel, of the Department of Zoology, University of Adelaide, kindly sent me a sample of "*Pettancylus*" *australicus* (Tate, 1880, p. 102, pl. 4, fig. 4a-b) from the Torrens River, South Australia. The sample contained 168 specimens. One sectioned specimen appeared to be aphallic. Subsequent examination by transparent light revealed that aphaly is the normal state in this species or at least in the population examined. Only ten of the 168 species appeared probably to be phallic by this preliminary examination. Checking by serial sectioning showed that only seven specimens in the total sample had a complete reproductive system. These conditions add to the interest of the species, and a general morphological account of it may be of some value. This account is based on the intact specimens of the sample, nine serially sectioned specimens, and radula mounts.

The shell (Text figs. 1-3) reaches a maximum length of 3.8 mm. in the material examined. The corresponding maximum breadth is 2.2 mm., and height 1.0 mm. The size proportions vary slightly. The apex is smooth, but at a magnification of 50x a faint radial sculpture is sometimes visible on the apical region. The apex is located near the right side of the shell and about ¼-⅙ of the shell length from its rear end. The location of the apex and the morphology of the body indicates a vestigial pseudodextral shell. The anterior end of the shell is bluntly rounded, the posterior end somewhat more pointed, and located to the left of the median line. An extremely faint concentric sculpture is present. The transparent periostracum reaches well beyond the calcareous shell border. The colour of the shell is pale yellowish-brown.

One of the 168 specimens is septate (Text figs. 2-3), having the posterior part of the aperture closed by a septum of complete shell material. Some authors have regarded this feature as being of taxonomic importance, whereas others have regarded it as a kind of ecophenotypical adaptation (cf. Basch's review of the problem, 1959). The present case of septation does not support any of these views.

As in ancylids in general, the eaves-like mantle border runs all around the animal. The foot has a somewhat rectangular sole. The tentacles are slender but not sharply pointed. A rather thin, unbranched but slightly folded pseudobranch is present. The anterior end of this gill is thicker and the anal pore is located on its dorsal surface. The mantle opening, the excretory pore and the genital pores are also on the left side of the animal.

There are three strong so called shell adductors (text fig. 5), one on either side anteriorly and one posteriorly to the left. Between the two left adductors is the shallow, widely open mantle cavity. Above the anteriorly located main portion of this is part of the pericardium, which reaches further to the right. A narrow reno-pericardial duct connects the lumen of the pericardium with that of the kidney. This has a

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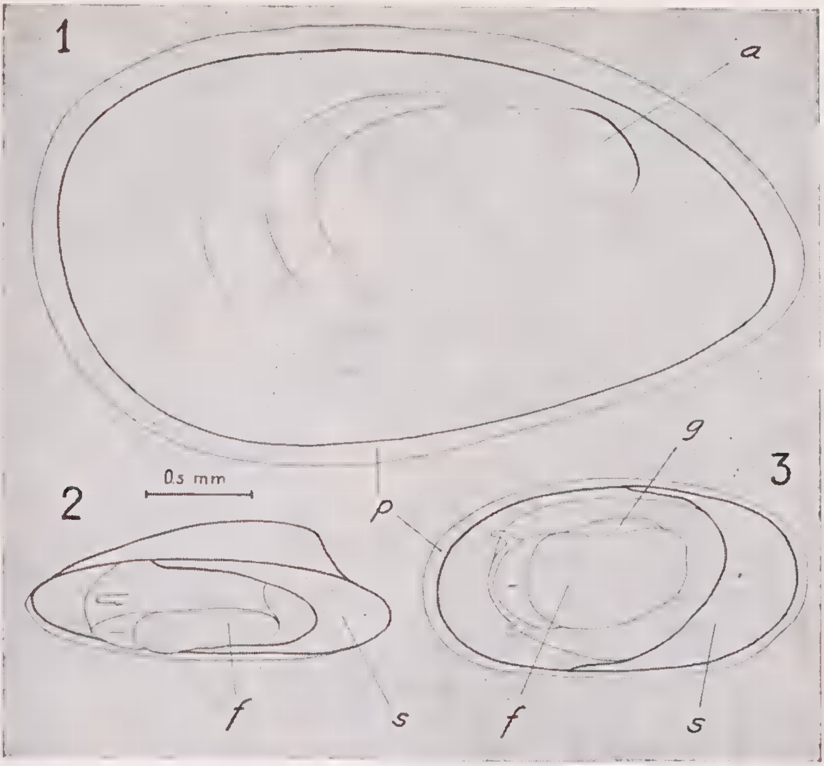

Text figs. 1-3.

"Pettancylus" australicus (Tate).

1. Dorsal view of shell.

2. Oblique left side view of septate shell with animal.

3. Ventral view of same specimen as in fig 2.

a, apex. *f*, foot. *g*, pseudobranch. *p*, periostracal shell edge. *s*, septum.

sac-like proximal portion and a sausage-shaped distal portion, which continues directly in the almost equally long urethra. The renal pore near the posterior end of the urethra is extremely narrow, and opens out under the mantle border. The kidney and the urethra form together a serpentine duct. The junction between its two elements is at the bend near the left posterior corner of the pericardium.

An osphradium is located in the mantle furrow near the left anterior shell adductor.

The jaw consists of a single row of separate chitinous condensations along the anterior and lateral sides of the mouth. The number of such chitin bars is about 75.

The buccal bulb occupies the major part of the head. The salivary glands (text fig. 6) are comparatively short and joined behind above the oesophagus. Their ducts are slender. The radula sac is short. The radula (text fig. 4) has about 27 teeth per cross row. The central tooth is symmetrical and has six cusps; of these the two central ones predominate, the more peripheral cusps are small and the most peripheral ones are visible only when the tooth is dislocated. The lateral teeth have up to eleven cusps. The four most peripheral teeth may be regarded as marginals, although a real distinction between laterals and marginals does not exist.

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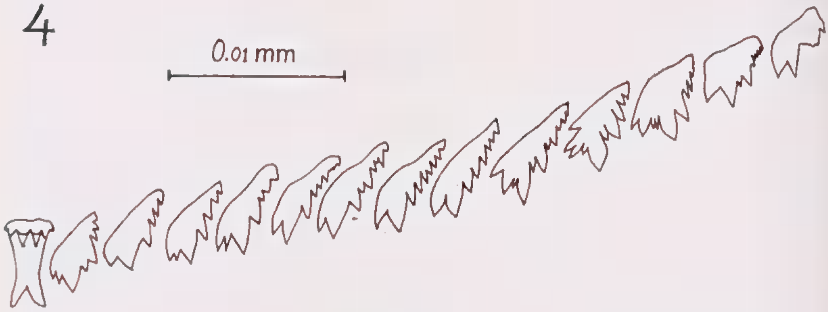

Text fig. 4.

"Pettancyclus" australicus (Tate).

Half a cross row of the radula.

The oesophagus increases slowly in width behind the buccal bulb. There is no crop, but the oesophagus joins directly the well-developed gizzard. The pylorus region of the stomach adheres to the dorso-posterior side of the gizzard. The two independent, richly branched complexes of the digestive gland are connected with the pylorus. From this, near the pore of the anterior gland complex, a well-developed coecum branches off from the pylorus. The intestine leaves the pylorus parallel with the coecum and makes two loops before merging into the rectum. This runs towards the middle portion of the left side of the body. The anal pore is situated in the pseudobranchial fold.

Text figs. 5-7.

"Pettancyclus" australicus (Tate).

5. Diagram of adductor muscles and pallial organs, Dorsal view. The line of small rectangles represents the mantle cavity and the junction between the mantle border and the main body.
6. Diagram of the alimentary tract. Dorsal view. The fine broken lines indicate the outline of the digestive glands.
7. Diagram of the reproductive system, viewed from the left.

a, adductor muscles. *a.g.*, albumen gland. *ao.*, aorta. *a.p.*, anal pore. *c.*, caecum. *ca.*, carrefour. *d.g.*, digestive glands. *e.p.*, excretory pore. *fl.*, flagellum. *fp.*, female genital pore. *gi.*, gizzard. *go.*, gonad. *i.*, intestine. *k.*, kidney. *m.o.*, male copulatory organ. *m.p.*, male genital pore. *o.*, osphradium. *o.e.*, oesophagus. *p.c.*, pericardium. *pr.*, prostate. *py.*, pylorus. *r.p.d.*, reno-pericardial duct. *r.s.*, radula sac. *s.g.*, salivary gland. *sp.*, spermatheca. *u.*, urethra. *u.c.*, uterine gland complex. *v.s.*, vescular seminalis.

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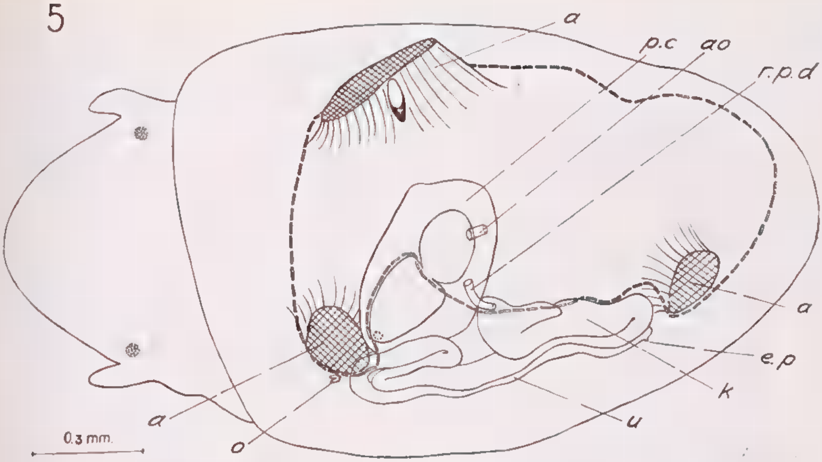

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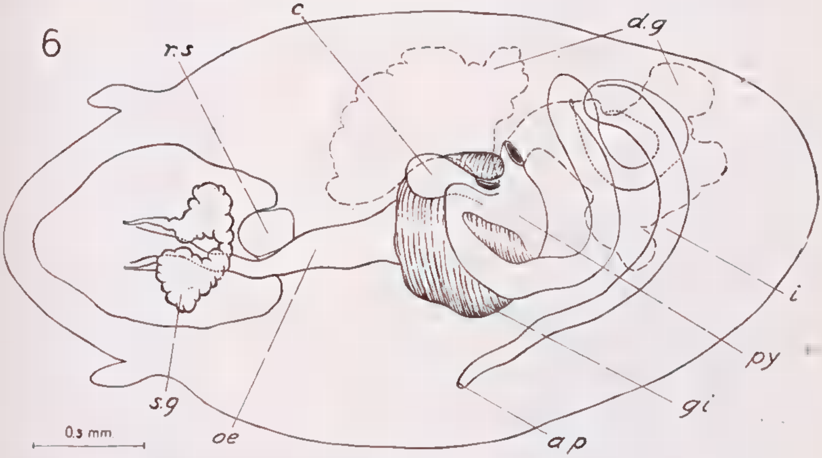

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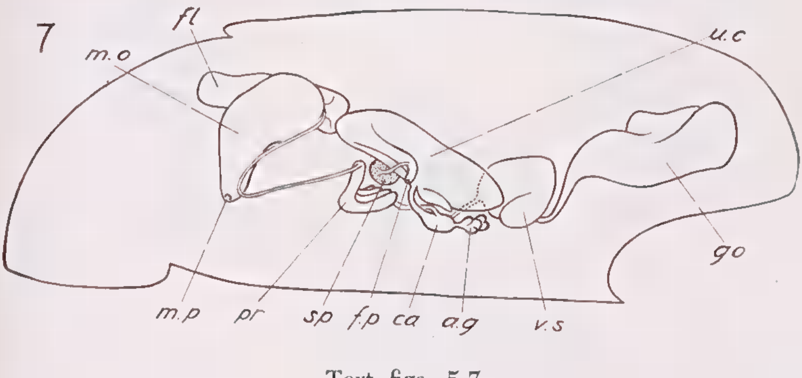
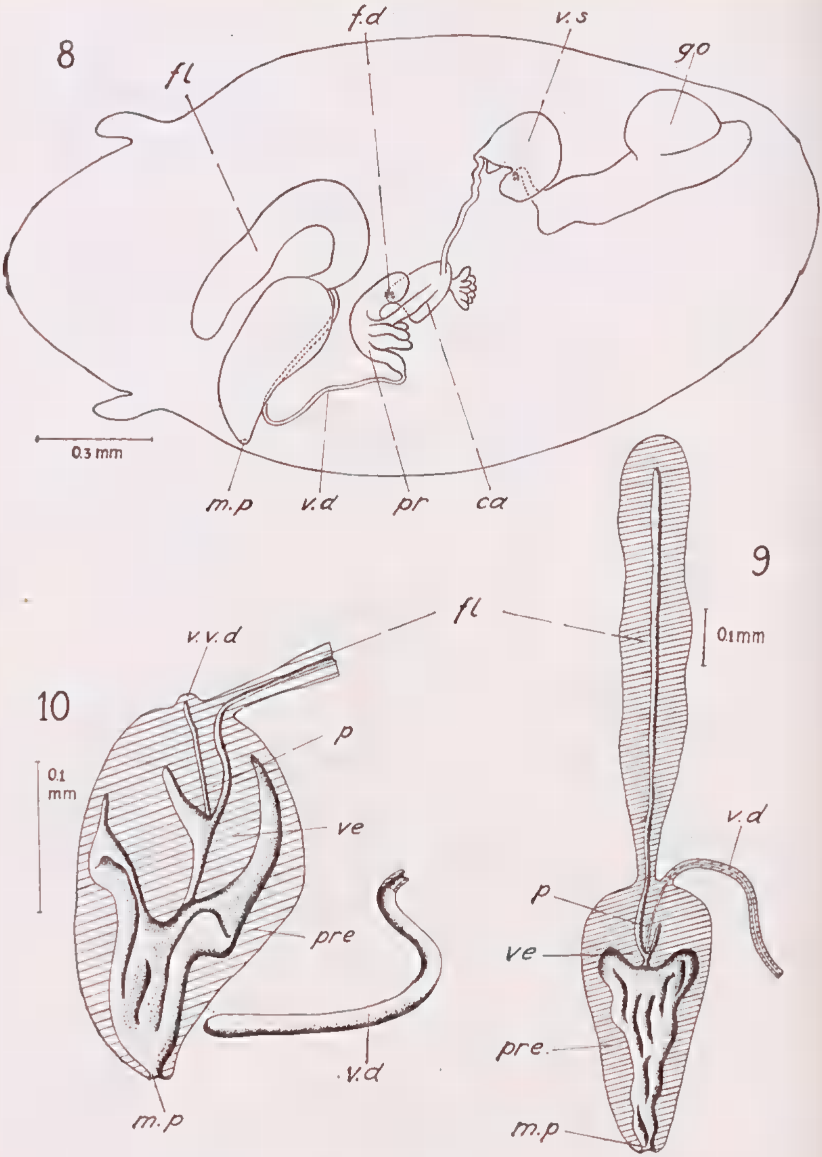


Text figs. 5-7.



Text figs. 8-10.

"*Pettancylus*" *australicus* (Tate).

8. Diagram of genital system, distal female componants removed: dorsal view.
9. Diagram of longitudinally sectioned male copulatory organ with flagellum.
10. Diagram of longitudinally sectioned incomplete male organ. Cut surfaces parallely ruled.

ca., carrefour. *f.d.*, beginning of female duct. *fl.*, flagellum. *go.*, gonad. *m.p.*, male genital pore. *p.*, penis. *pr.*, prostate. *pre.*, preputium. *v.d.*, vas deferens. *ve.*, velum. *v.s.*, vesicula seminalis. *v.v.d.*, vestige of vas deferens.

The apically located gonad is bifurcated only (text figs. 7-8). In its uppermost parts only eggs are formed, in its lower parts both eggs and spermatozoa. The efferent duct leads to a rather large, thin-walled vesicula seminalis. From there the common duct runs to the carrefour. The albumen gland also joins this structure. From the carrefour the separate male and female ducts go off, the former to the prostate, the latter to the uterine gland complex. The prostate has around five diverticula branching off from a swollen portion of the male duct. The latter continues as the vas deferens to the male copulatory organ, which it enters parallel with the large glandular flagellum. The male organ is not externally divided in a penis sheath and a preputium, but internally there is a dividing velum formation (text fig. 9). The penis is small and has a terminal pore. The lumen of the flagellum continues in the proximal end of the lumen of the penis sheath. In the preputium there are no real muscular pillars, but irregular fold formations. The male genital pore is situated behind the left tentacle.

The large uterine gland complex merges, at its anterior end, into the slenderer structure which, after joining the thin spermathecal duct, leads to the female pore. This is located on a small papilla below the anterior end of the pseudobranchial flap. The spermatheca is roundish and of moderate size.

In the central nervous system the cerebral and pleural ganglia are fused on either side. This fusion is particularly intimate on the right side. The visceral commissure has three ganglia, of which the middle and left ones are rather diffusely delimited from each other. The pedal commissure is comparatively thin. Behind this is a very slender para-pedal commissure.

Before ending this brief description of the topographic morphology in *Pettancylus australicus*, a further note on the aphally and related conditions in this species may be worth while. As mentioned above, the vast majority of the specimens in the sample examined are aphallic. Serial sections of one of these specimens show that even here both eggs and spermatozoa are formed in the gonad. Apart from the male copulatory organ also the vas deferens is missing. The prostate is strongly reduced. Of the phallic specimens eight were serially sectioned. In seven of these both eggs and sperm cells were present in the gonad, whereas in the eighth the whole gonad was degenerated. Another sectioned specimen, finally, showed a sort of intermediate state between the phallic and aphallic condition. In this specimen the whole male copulatory organ was present, but the distal portion of the vas deferens absent (text fig. 10). A little knob on the proximal end of the male copulatory organ indicates the place where the vas deferens should have entered. The remaining distal part of the vas deferens was somewhat swollen, thin-walled and full of spermatozoa. In the same specimen certain parts of the uterine gland complex showed an enormous hypertrophy.

The species under consideration was originally described by Tate as *Ancylus australicus*. The type species of *Ancylus*, *A. fluviatilis* Müller, is, however, anatomically different to an extent that justifies generic discrimination. Iredale (1943) placed the species in his genus *Pettancylus*. However, this genus has never been defined, and its type species, *P. tasmanicus* (Ten.-Woods) has not been anatomically examined. Iredale

separated the "southern" ancylids from *Ferrissia* without any appropriate reason. *"Pettancylus" australicus* has a male copulatory organ which is similar to that of the Indian *Ferrissia tenuis* (Bourguignat) (Hubendick, in press) and probably similar to those of *F. tarda* (Say) (Hoff 1940) and *F. parallela* (Haldeman) (Baker 1928), although differences occur in other organs. However, the type species of *Ferrissia* is *F. rivularis* (Say), and according to my own tentative examination the male copulatory organ is here distinctly different from those in the above-mentioned species. The conclusion to be drawn from this is that it is too early to settle the taxonomic classification of *"Pettancylus" australicus*. The same is true for most ancylids, and the author is slowly collecting information which will enable him to revise the taxonomy of the Ancylidae.

REFERENCES.

BAKER, F. C., 1928. The fresh water mollusca of Wisconsin, Pt. 1. *Bull. Wis. geol. nat. Hist. Surv.*, 70.

BASCH, P. F., 1959. Status of the genus *Gundlachia* (Pulmonata, Ancylidae). *Occ. Pap. Mus. Zool. Univ. Mich.*, 602.

HOFF, C. C., 1940. Anatomy of the ancylid snail, *Ferrissia tarda* (Say). *Trans. Amer. micr. Soc.*, 59: 224-242.

HUBENDICK, B., in press. On the family Ancylidae with special regard to *Ferrissia tenuis* (Bourguignat), the suspected intermediate host of *Schistosoma haematobium* in India. *Proc. VI Congr. Int. Med. Trop. Paludismo.* Lisboa.

IREDALE, T., 1943. A basic list of fresh water mollusca of Australia. *Aust. Zool.*, 10: 188-230.

TATE, R., 1880. Descriptions of some new species of South Australian Pulmonifera. *Trans. roy. Soc. S. Aust.*, 3: 102, pl. 4, fig. 4, a-b.

NON-MARINE MOLLUSCA FROM THE FLORIDA ISLANDS, SOLOMON ISLANDS

By ALAN SOLEM, Ph.D.*

ABSTRACT.

Land and freshwater molluscs collected on Florida and Tulagi Islands by Robert E. Kuntz in 1943-1945 are reviewed. New species are *Mocella kuntzi, Orpiella kuntzi, Palaina floridana, Palaina clappi,* and *Palaina megamorpha.* Several other species are reported from the Solomons for the first time.

INTRODUCTION.

Very little is known of the Solomon Island molluscan fauna. Clench (1941: 1-3) summarized the history of early collecting, and references to studies on the marine molluscs can be found in Solem (1953, 1958). Papers on the non-marine fauna are few, those of Smith (1885), Clapp (1923), I. and B. Rensch (1935, 1936), Clench (1951, 1958) and Dell (1955a, 1955c) providing the only data other than scattered species descriptions. Most of these papers cover general collections, the only islands specifically considered being Nissan (Dell, 1955a), the Treasury Group (Dell, 1955c), and Rennell Island (Clench, 1958).

Robert E. Kuntz was stationed on Florida Island from 1943 to 1945. He collected molluscs from sixty localities on Florida and Tulagi Islands (identified by the FLW and ML numbers in the text). A map showing the exact location of each site is on file in the Mollusk Division of the University of Michigan Museum of Zoology. Some stations were in brackish water or marine habitats, and reference to these may be found in Solem (1958).

Prior to Kuntz's work, only eleven species were recorded from Florida Island and three from nearby Tulagi. Kuntz collected thirty-two different molluscs on Florida Island and eight on Tulagi. Five species are new to science, and several genera of minute snails were previously unreported from the Solomons. This reflects the fact that, except for R. K. Dell, no malacologist has collected in the Solomons. Most material has been brought back by missionaries, traders, planters, or vertebrate zoologists who collect only the large, spectacular *Placostylus, Papuina,* and *Chloritis,* and ignore the rich fauna of minute species.

Kuntz made even larger collections in the New Hebrides, which were studied at the same time, and are reported on elsewhere (Solem, 1959a, 1959b). Most of his material is deposited at the University of Michigan Museum of Zoology, with some duplicate sets in the Chicago Natural History Museum.

Specimens from several institutions were studied in comparison with Florida Island material. For convenience, the following abbreviations identify the location of material referred to in the text:—

*Curator of Lower Invertebrates, Chicago Natural History Museum, Chicago, Ill.

AMNH American Museum of Natural History.
ANSP Academy of Natural Sciences, Philadelphia.
BPBM Bernice P. Bishop Museum, Honolulu.
CM Carnegie Museum, Pittsburgh.
CNHM Chicago Natural History Museum.
MCZ Museum of Comparative Zoology, Harvard.
UMMZ University of Michigan Museum of Zoology.

Available data concerning the FLW and ML sites referred to below and in Solem (1958) are given in the appendix. (See p. 53.)

SYSTEMATIC REVIEW.

Family Pupillidae.

Gastrocopta (Sinalbinula) pediculus (Shuttleworth, 1852).

FLW 38, FLW 40.

Family Tornatellinidae.

Lamellidea pusilla (Gould, 1847).

FLW 40.

Identified by Dr. Yoshio Kondo. Possibly *L. solomonensis* Dell (1955b) is a synonym of the widely distributed *L. pusilla.*

Family Partulidae.

There is insufficient material in museum collections to evaluate the specific status of the many named Solomon Island *Partula.* They present a uniform appearance of shells 16-17 mm. high, light greenish-horn in colour (sometimes with white bands), and very prominent spiral sculpture. Specimens from the Bismarcks, Admiralties, and Louisiades are very similar to those from the Solomons. The status of the "*Partula*" reported from Western New Guinea is uncertain. The early species named by Lesson have not been rediscovered, while Iredale (1941: 64) created the genera *Scilistylus* and *Amimopina* for other species. *Scilistylus* remains enigmatic, but *Amimopina* is probably an enid. (See Solem, 1959c).

The New Hebridean partulids are usually associated with those from northern Melanesia. The former are quite different, being more than 20 mm. high, with a more elongate spire, much weaker spiral sculpture, and with longitudinal brown streaks on a lighter background. Two New Hebridean species resemble the Solomon Island type (see Solem, 1959b: 71-73), but the others are readily distinguishable.

One Florida Island specimen was identified through comparisons with Hartman's types in the CM.

Partula coxi Hartman, 1886.

Partula coxi "Angas" Cox, 1868, Exchange List, p. 46, No. 152 (Ysabel Island) (*nomen nudum*); Hartman, 1886, *Proc. Acad. nat. Sci. Philad.*, 1886: 32, pl. 2, fig. 7 (Ysabel Island); Pilsbry, 1909, Man. Conch., (2), 20: 296-297, pl. 36, figs. 1-4.
FLW 37.

The shell appears inseparable from the holotype of *Partula coxi,* and differs only slightly from *Partula pellucida* (Pease). Possibly both named forms were collected from Ysabel Island, the cited type localities of Hartman often being in error (see Solem, 1959b: 72). Dell (1955c:

428) reported a shell from Mono Island (Treasury Group) which may be the same species as the Florida shell.

Family Endodontidae.

The Solomon Island species include the large, scalariform endemic genus *Foxidonta* (Clench, 1950), and several quite minute species which have been referred to several different genera. *Endodonta solomonensis* Clapp, *Gyropena nissani* Dell, and a new species are discussed below. Clench (1958: 173-174) recently described two "*Charopa*" from Rennell Island. These species are probably not congeneric with the New Zealand *Charopa*, and may not be endodontids, but rather aberrant paryphantids. The information needed to determine their generic position was not given in the original description, and may be obtainable only from dissection of the soft parts.

Stenopylis coarctata (Moellendorff) was discussed fully by Solem (1957). It has an amazingly wide distribution, ranging from Central Australia, the Solomons and New Guinea to the Philippines and Java.

Mocella solomonensis (Clapp, 1923). (Plate 4, figs. 1-5).

Endodonta (*Charopa*) *solomonensis* Clapp, 1923, *Bull. Mus. comp. Zool., Harv.*, 65: 378, figs. 21-24 (Ugi, Solomon Islands).

Holotype from Ugi, Solomon Islands.

The only known specimen is rather worn, but traces remain of the apical sculpture (Fig. 4), and show that this species belongs to the *Mocella* complex. The original illustrations are not fully satisfactory, and the species has been refigured here, including a greatly enlarged drawing of microsculpture between the major radial ribs (Fig. 5).

Generic placement of the Pacific endodontids is difficult. A wide ranging group of toothless shells has the same spiral apical sculpture and microsculpture between the ribbing. Many generic names have been applied to this complex, which is found in Polynesia, Melanesia, New Zealand, Australia, and Lord Howe Island. The earliest appears to be *Mocella*, and, until finer distinctions can be made, I'm utilizing this name for the entire series (see Solem, 1959b: 83). The three species discussed here, *solomonensis, nissani,* and *kuntzi,* are referred to *Mocella.*

Mocella kuntzi sp. nov. (Plate 5, A, figs. 1-3).

Diagnosis: A species of *Mocella* separated from *M. solomonensis* by its smaller size (2.0 against 2.8 mm.), more crowded sculpture, and slower rate of whorl increment; from *M. nissani* by its narrower umbilicus and slightly higher shell.

Description: Shell minute, depressed-helicoid, spire only slightly elevated. Whorls 3¼ to 3⅞, very slowly increasing in size. Sutures moderately impressed, whorls convex. Aperture ovate, strongly compressed above. Umbilicus deep, open, contained about four times in the diameter. Apical whorls 1½, finely spirally ribbed. Spire and body whorl with strong radial ribs (68 on whorls 2-3; 104 on whorls 3-4). Microsculpture of fine riblets crossed by spiral lines between the primary ribs. Colour reddish-brown. Diameter, 1.9-2 mm., height 1.0-1.3 mm.

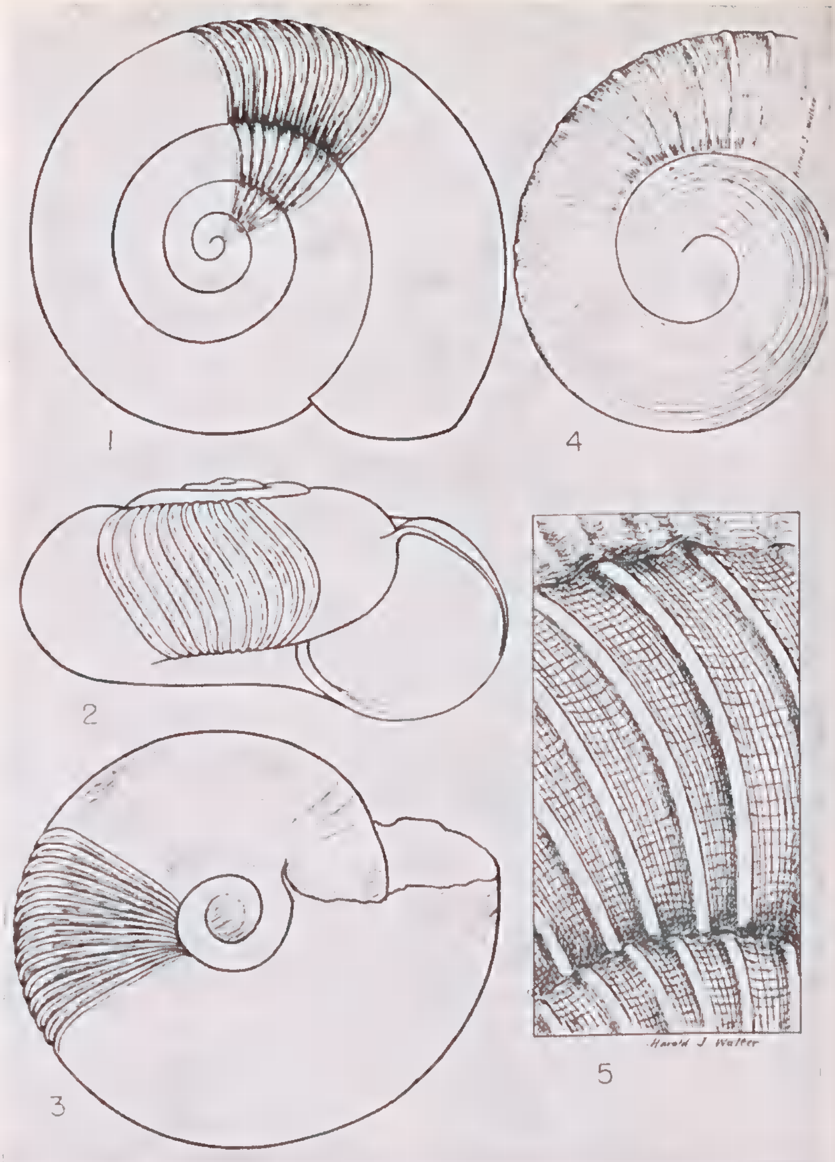


PLATE 4.

Mocella solomonensis (Clapp). Holotype.

Fig. 1 Top view.
Fig. 2. Side view.
Fig. 3. Bottom view.
Fig. 4. Apical sculpture.
Fig. 5. Microsculpture between radial ribs.

Type Locality: Peninsula east of Halavo, Florida Island, Solomon Islands (FLW 38). In leaf mould. November, 1944.

Types: The holotype is University of Michigan Museum of Zoology No. 186035. Paratypes from FLW 38 and FLW 40 are UMMZ 186034, MCZ 186827, and CNHM 54905.

Remarks: Mocella kuntzi is most closely related to *M. nissani* (Dell, 1955a: 328, figs. le-g), but differs in umbilical size. They may be only subspecifically distinct, but at present may best be considered full species. The variation in two lots of *M. kuntzi* is summarized in Table 1.

Table 1.

Mocella kuntzi.

	FLW 38 (UMMZ 186034)		FLW 40 (UMMZ 186035)	
	Mean	Range	Mean	Range
Diameter	2.07	1.90-2.23	2.07	1.94-2.23
Height	1.16	1.10-1.29	1.11	1.03-1.16
H/D ratio	0.56	0.53-0.61	0.54	0.49-0.56
Whorls	3 11/16	3½-3⅞	3⅝	3½-3¾
Umbilicus	0.50	0.45-0.54	0.53	0.48-0.64
D/U ratio . .	4.15	3.84-4.28	3.93	3.46-4.34

All measurements in mm.

Stenopylis coarctata (Moellendorff, 1894).

FLW 38, FLW 40.

Family Helicarionidae.

Liardetia (*Liardetia*) *samoensis* (Mousson, 1865).

FLW 38.

Ranges from the Bismarcks and New Caledonia east to the Marquesas.

Liardetia (*Liardetia*) *nissani* (Dell, 1955).

Orpiella (*Owaraha*) *nissani,* Dell, 1955, *Pacific Sci.,* 9: 326-327, figs. la-c (Tangalan Plantation, Nissan Island, Solomon Islands).

Through the kindness of Dr. Yoshio Kondo, it was possible to examine a paratype (BPBM 212366). Apparently this species is very closely related to *L. samoensis,* differing only in having less prominent radial sculpture, more crowded spiral sculpture on the base, a slightly slower rate of whorl increment, and a more depressed shape. The differences are all of degree, the sculptural details and general aspect of *nissani* being very similar to *samoensis.* The sculpture and other shell features resemble much more closely *Liardetia* than any *Orpiella.* Pending study of the soft parts, I'm tentatively transferring *nissani* to *Liardetia.*

Wilhelminaia mathildae Preston, 1913.

FLW 38, FLW 40.

The same species is found in the New Hebrides (Solem, 1959b: 92-94), and probably ranges through Indonesia.

PLATE 5.

A. *Mocella kuntzi sp. nov.* Holotype.
Fig. 1. Bottom view. Fig. 2. Top view. Fig. 3. Side View.

B. *Orpiella kuntzi sp. nov.* Holotype.
Fig. 1. Side view. Fig. 2. Top view. Fig. 3. Bottom view.

Orpiella kuntzi sp. nov. (Plate 5, B, figs. 1-3).

Diagnosis: A species of *Orpiella,* the same size as *O. malaitensis* (Clapp) and *O. treasuryensis* (Tryon), which differs from the former by its less open umbilicus, more reflexed columella, lower spire and more angulated periphery, and from the latter by its much lower spire, greater number of whorls and more angulated periphery.

Description: Shell solid, slightly elevated, shining, with faint radiating lines at regular intervals. Whorls 5½ to 5⅞, regularly increasing in size, sutures slightly impressed, whorls of spire gently rounded, body whorl obliquely angulated above the middle of the whorl, flatter above the angulation, more rounded below. Aperture ovate, slightly compressed laterally, lip slightly thickened. Umbilicus closed apically, but with an umbilical chink partially covered by a reflection of the columellar lip. Parietal callus thin and somewhat opaque. Diameter 13.0-14.0 mm., height 6.8-7.5 mm.

Type Locality: One mile in jungle behind Halavo, Florida Island, Solomon Islands at 200 feet elevation (FLW 15). Robert E. Kuntz, collector. October 1, 1944.

Types: The holotype is University of Michigan Museum of Zoology No. 184473. Paratypes are UMMZ 184474 (FLW 15) and UMMZ 184475 (FLW 4).

Remarks: O. kuntzi is perhaps most similar to *O. malaitensis,* but comparison with the holotype of the latter (MCZ 32553) showed the differences mentioned in the diagnosis. References to the previously described Solomon Island *Orpiella* can be found in Clapp (1923: 355-361) and I. and B. Rensch (1936: 654-659).

Dendrotrochus (Dendrotrochus) cleryi cleryi (Recluz, 1851).

FLW 42, FLW 52.

The shells are the same morph that H. B. Baker (1941: 256-257) reported from Three Sisters Island (ANSP 151452). Although Clapp (1923), I. Rensch (1934), Dell (1955c), and Clench (1958) reviewed the Solomon Island *Dendrotrochus,* their taxonomy is still unsettled. Both ecological and anatomical studies are needed before speciation patterns can be discerned.

Family Zonitidae.

Trochomorpha (Lentitrochus) xiphias floridensis Clapp, 1923.

Trochomorpha floridensis Clapp, 1923, *Bull. Mus. comp. Zool., Harv.,* 65 (11), p. 367 (Florida Island, Solomon Islands).

FLW 4, FLW 15, FLW 21, FLW 23, FLW 24, FLW 26, FLW 29, FLW 30, FLW 32, FLW 35, FLW 52.

T. x. floridensis has a higher, more convex spire and a less convex, less inflated base than *T. x. xiphias.* Other material examined from Tulagi (AMNH 70778) and Ysabel Island (MCZ 32518) does not differ significantly from the types (MCZ 32516, MCZ 73674). On Florida Island itself there is considerable variation.

Behind Halavo a peak rises from sea level to 1010 feet. Collections of *T. x. floridensis* from sea level to 500 feet showed a clinal variation in colour pattern, size and whorl count. No collections were made above

500 feet, and the variation from there to the summit remains to be investigated.

Specimens matching the types came from stations 21, 26, 35 and 52. The altitude of FLW 26 is unknown, but the other three lie between three and sixty feet above sea level. The shells are large (average diameter 15.2 mm., range 13.7-17.3, with 5⅛ whorl average). They have a light background colour, two or three narrow spiral red bands above and two below the periphery. The bands are all narrower than their interstices.

Stations 29 and 30 were at about 100 feet elevation. The shells are smaller (average diameter 13.3 mm., range 13.0-13.8, with a 5 whorl average), with a darker background colour, and less prominent red bands which are wider than their interstices.

Shells from stations 4, 15, 21, and 24 were still smaller (station 24, for example, 13 shells average diameter 11.8 mm., range 10.4-12.9, with a 4⅞ average whorl count). FLW 21 was bleached stream drift, but the other stations were 200 to 500 feet in elevation. The shells had a very dark background colour and only faint traces of very wide colour bands.

Material from FLW 23 and FLW 32 was juvenile. The probable cause of this variation is unknown. The genital anatomy of material from FLW 52 differed from that of *T. sanctaeannae* in having the vagina shorter and the talon smaller and less clearly bifurcate. The epiphallus is not sharply separated from the penis, but there is a zone of transition from the narrow pilasters of the epiphallus to the broader ones of the penis. One specimen yielded a small, flat, oval spermatophore.

Family Subulinidae.

Subulina (Subulina) octona (Bruguiere, 1792).
FLW 16, FLW 42, FLW 43.

Lamellaxis (Allopeas) gracilis (Hutton, 1834).
FLW 38, FLW 40, FLW 42, FLW 43.

Family Streptaxidae.

Gulella (Huttonella) bicolor (Hutton, 1834).
FLW 16, FLW 32, FLW 33.
A species widely disseminated by commerce.

Family Bulimulidae.

Placostylus (Placocharis) kreftii (Cox, 1872).
FLW 4, FLW 15, FLW 24, FLW 43.

Forty-five specimens of *P. kreftii* were examined. Size and shape varied considerably (see Table 2), encompassing the slender form *artus* and relatively obese shells. The parietal tooth was well developed in most specimens, but was greatly reduced or absent in about one-fourth of the shells.

The relationships of *P. kreftii* are uncertain. Clench (1941) associated it with *P. cleryii* (Petit) in *Eumecostylus*, while others place it with *P. palmarum* (Mousson) and *P. macgillivrayi* (Pfeiffer) in *Placocharis*. The two subgenera are only weakly characterized and they may eventually be combined.

Family Camaenidae.

Australian workers divide this into a number of families, generally based on shell structure. The Australian genera are no more diverse than the West Indian taxa studied by Wurtz (1955). My own dissections of Pacific species and the anatomical data in the literature provide no criteria justifying family separation of the Pacific and West Indian genera, much less recognition of separate family groupings in the Australian region.

Eustomopsis customus (Pfeiffer, 1857).

FLW 4.

Chloritis quercina (Pfeiffer, 1857).

FLW 2, FLW 4, FLW 42, FLW 52.

The twenty-five specimens collected by Kuntz belong to the variety *hombroni*. Some populations of this species show intergrades between typical *quercina* and *hombroni* (see Clench, 1958: 197-198), but the Florida Island populations sampled show little variation (Table 2). Typical *quercina* has a H/D ratio of 75-80, while the Florida population averages 61.5.

Clench (1958:198) described *Eustomopsis renschi* from Tulagi Island. It was not collected by Kuntz, but from available data seems to be only an extreme variation of the *quercina* complex. Possibly it is only subspecifically separable.

Papuina aff. *caerulescens* (Angas, 1869).

FLW 35, FLM 42.

The two shells have the protractive striae of the *eddystonensis* complex, but the umbilicus is less open, the body whorl more rounded, and the columellar lip broader and flatter than in any described species. *P. caerulescens* appears to be the nearest relative, but the Florida shells have a broader basal lip, less deeply excavated peristome, less angulated periphery, and a different colour pattern. Too little material is available to warrant naming.

Papuina meta meta (Pfeiffer, 1856).

FLW 4, FLW 15, FLW 23.

The six specimens are nearest those figured by Pilsbry (1891: pl. 9, fig. 60).

Papuina meta acmella (Pfeiffer, 1860).

FLW 4, FLW 35.

Four specimens of this colour form were collected.

Papuina ambrosia (Angas, 1867).

FLW 4, FLW 12, FLW 13, FLW 14, FLW 24, FLW 26, FLW 30, FLW 35, FLW 42, FLW 52.

This species is widely distributed in the Central Solomons and was the commonest large snail found by Kuntz. I. Rensch (1934: 4-5) recognised a subspecies, *ramsdeni* Angas, from Choiseul and Florida Islands. The thirty-five adult shells found by Kuntz are much nearer the typical *ambrosia* than the large *ramsdeni* (see Table 2). Different

populations on Florida Island may have been sampled, or the shells seen by I. Rensch were simply the result of a favourable year.

Table 2.

Placostylus, Chloritis, and *Papuina.*

		P. kreftii	*C. quercina*	*P. ambrosia*
Height	Mean	53.6	21.3	21.9
	Range	48.2-64.0	19.0-24.4	18.0-26.3
Diameter	Mean	21.6	34.6	21.2
	Range	20.1-24.5	29.6-36.7	17.2-25.6
H/D ratio	Mean	2.50	0.62	1.04
	Range	2.26-2.85	0.567-0.651	0.92-1.27

Family Planorbidae.

Gyraulus (Pygmanisus) corinna (Gray, 1850).

ML 100.

Most of the specimens were relatively small (1.65 mm. in diameter with 2½ whorls). The largest individual (2.22 mm. in diameter with 3¼ whorls) was identical with typical Fijian specimens ("*singularis* Clessin") and smaller Tasmanian ("*scottianus* Johnston") and New Zealand ("*corinna* Gray") shells. The minute planorbid snails vary greatly under differing ecological conditions, and it is not impossible that the above names refer to only one widely distributed species. Rather than add to an overburdened taxonomy, I have utilized the oldest available name for the Solomon shells.

Family Helicinidae.

I. and B. Rensch (1936: 679-683), Dell (1955a, 1955c) and Clench (1958: 159-164) provide recent records for Solomon Island helicinids. The identity of the shell that Dell (1955c: 426) reported as *Geophorus agglutinans* (Sowerby) is puzzling. *Geophorus* is a Philippine-Indonesian genus, and *G. agglutinans* a common Philippine species. Its occurrence in the Solomons would be most unexpected. Possibly this record is based on specimens of *Pleuropoma sophiae* (Brazier), which was described from the Treasury Islands, and is somewhat similar to *G. agglutinans* in shape and colour.

Palaeohelicina egregium (Pfeiffer, 1855).

FLW 4, FLW 8, FLW 11, FLW 13, FLW 14, FLW 24, FLW 26, FLW 30, FLW 32, FLW 35.

There is considerable variation in the colour banding of this common species. All specimens had a single red spiral band just below the keel, which varied in width from one to two millimeters. Many had a lighter, wider band above the periphery midway between the keel and suture.

Typical *egregium* is known from the Florida group, Malaita, and Stirling Islands. I. and B. Rensch (1936: 679) and Clench (1958: 162)

report *P. moquiniana* (Recluz) from Tulagi, but all the Kuntz specimens from Tulagi (FLW 8, FLW 11) were *P. egregium*.

Sturanya modesta (Pfeiffer, 1853).

FLW 26, FLW 29, FLW 30, FLW 32, FLW 38.

The original locality of *S. modesta* was given as Tanna, New Hebrides. E. A. Smith (1885: 598-599) established the identity of the types with the Solomon Island species. No helicinid resembling *modesta* is found in the New Hebrides (Solem, 1959b: 178), and circumstantial evidence suggests that the locality is erroneous, the type localities of a New Hebridean *Pupina* and *S. modesta* having been switched in manuscript.

Solem (1959b: 168) accepted the type designation of H. B. Baker (1922: 43) for *Sturanya*, which led Pilsbry and Cooke (1934) to propose a substitute name, *Sturanyella*. H. B. Baker (personal letter) called my attention to an overlooked type designation by Kobelt in a review of Wagner's studies. The type of *Sturanya* Wagner, 1905 is *Helicina plicatilis* Mousson by subsequent designation of Kobelt (1905: 207). *Sturanyella* thus becomes an objective synonym of *Sturanya*.

Family Pupinidae.

Pupina (*Pupina*) *keradreni* Vignard, 1829.

FLW 16, FLW 21, FLW 30, FLW 33, FLW 40, FLW 44, FLW 46.

Clench (1949: 31-33 and 1958: 166) maintained that *P. solomonensis* and *P. keradreni* are distinct species. This was questioned by Dell (1955c: 424), and Kuntz's collections do not support the separation. The two differ primarily in size, *P. keradreni* being 6.5-6.6 mm. high, and *P. solomonensis* 7.3-7.4 mm. high. Kuntz's twenty-five adult shells ranged from 6.1-7.5 mm. Twelve specimens were 6.8-7.0 mm. high, and one lot, FLW 44, contained shells 6.2, 6.4, 6.6, 6.7, 6.8, 6.9, 7.1, and 7.5 mm. high. The Florida and Tulagi populations are thus intermediate between *keradreni* and *solomonensis*. In the MCZ collection, typical *keradreni* is present from Ysabel, Rennell, Malaita and San Cristoval; typical *solomonensis* from Shortland and Choiseul; and intermediate sized shells from Florida and Tulagi. The relationship of the named forms is thus uncertain, but the problem requires more data than is available.

Family Cyclophoridae.

Leptopoma (*Dermatocera*) *perlucidum* (Grateloup, 1840) (= *vitreum* Lesson, 1831, not Draparnaud, 1801, and *nitidum* Sowerby, 1843).

FLW 15, FLW 20, FLW 45.

Generally this species is referred to as *vitreum* or *nitidum*, but I follow Forcart (1952) in accepting *Cyclostoma perlucida* Grateloup, 1840 as the earliest name for this species which is available.

Family Diplommatinidae.

Prior to this study, five diplommatinids were known from the Solomons—*Diplommatina brazieri* and *D. wisemanni* (Cox, 1870) from San Cristoval, and *D. aerari*, *D. solomonesis* and *Palaina gardneri* (Dell, 1955c: 424-425) from Mono Island, Treasury Group. Cox's species are unfigured and too vaguely described for comparison with the others. *Palaina gardneri* and *Diplommatina solomonensis* are dextral, and only *D. aerari* could be confused with the species described below. It is

readily distinguished by being 3.91 mm. high and having a weak tooth on the columellar lip.

Kuntz collected three species from leaf mould in the area behind Halavo (FLW 18). Their generic reference is uncertain. By definition, *Palaina* has no columellar tooth and *Diplommatina* a strong tooth on the columellar lip. All three Florida Island shells have a columellar tooth deeply recessed within the aperture. Study of specimens in the UMMZ and CNHM revealed that *Palaina taeniolata* Quadras and Moellendorff from Guam, Mariana Islands has a similar recessed tooth. Probably this character has developed several times in the diplommatinid stock, and the Florida species are provisionally referred to *Palaina*.

The three species are easily separable. *Palaina floridensis* is minute (height 2.11 mm.), has a relatively strong recessed columellar tooth and a circular thickened peristome; *P. clappi* is small (height 2.52 mm.), has a moderately developed recessed columellar tooth and a subquadrangular peristome closely appressed to the penultimate whorl; and *P. megamorpha* is large (height 4.51 mm.), has a weak recessed columellar tooth and an only slightly expanded peristome with a thin parietal callus.

Size variation in the three species is summarized in Table 3.

Table 3.
Palaina.

	P. floridensis	*P. clappi*	*P. megamorpha*
No. of specimens	17	4	1
Height of shell			
Mean	2.11 mm.	2.52 mm.	4.51 mm.
Range	1.96-2.26	2.48-2.59	
Diameter of shell			
Mean	1.24 mm.	1.64 mm.	2.32 mm.
Range	1.14-1.33	1.61-1.67	
H/D ratio			
Mean	1.70	1.54	1.95
Range	1.55-1.84	1.49-1.61	
Whorls			
Mean	5⅜	4⅞	6¼
Range	5¼-5¾	4¾-5	

Palaina floridensis sp. nov. (Plate 6, fig. 2).

Diagnosis: A minute Palaina with 4¼ whorls, a prominent columellar tooth deeply recessed within the aperture, a circular thickened peristome slightly elevated above the penultimate whorl and the body whorl overriding three-fourths of the penultimate whorl.

Description: Shell minute (height 1.96-2.26 mm.), sinistral, ovate-cylindric. Colour light brown. Whorls 5¼ to 5¾, sutures deeply impressed, later whorls tumescent. Body whorl slightly constricted behind, overriding about three-fourths of the penultimate whorl. Apical whorls 1¾ with weak, slightly protractive radial ribs. Remaining whorls with prominent, regularly spaced protractive radial ribs and a few fine spiral lines between the ribs. Aperture circular, with broadly expanded circular peristome slightly free of penultimate whorl. Strong columellar tooth deeply recessed within aperture. Operculum without calcareous elements, large, deeply concave, with central nucleus.

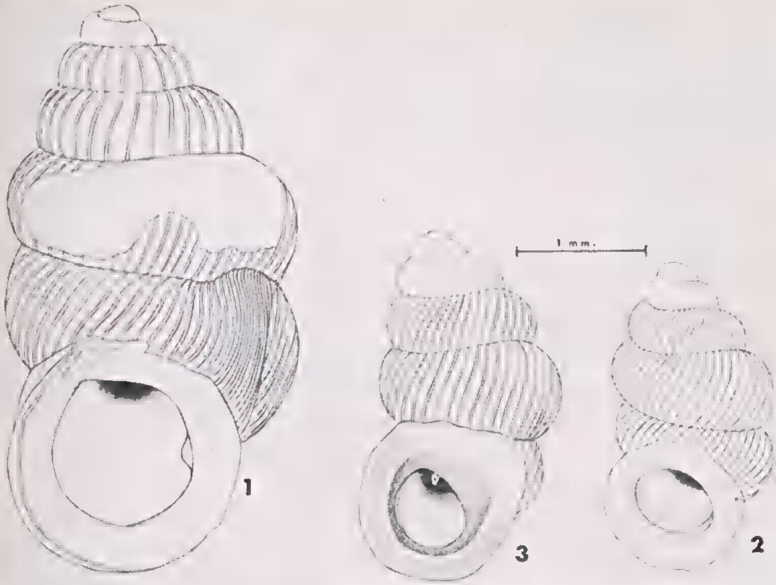


PLATE 6.

Fig. 1. *Palaina megamorpha. sp. nov.* Holotype.
Fig. 2. *Palaina floridensis, sp. nov.* Holotype.
Fig. 3. *Paliana clappi. sp. nov.* Holotype.

Type Locality: In leaf mould behind Halavo, Florida Island, Solomon Islands (FLW 18).

Types: The holotype is University of Michigan Museum of Zoology No. 181756. Paratypes are UMMZ 200494, CNHM 55208, and BPBM 212386.

Remarks: This was by far the commonest of the three species. Several individuals were collected alive and the operculum was "glued" to the aperture by the dry animal.

Palaina clappi sp. nov. (Plate 6, fig. 3).

Diagnosis: An average sized *Palaina* with 4¾ to 5 whorls, a moderately developed recessed columellar tooth, a subquadrangular thickened peristome closely appressed to the penultimate whorl, and the body whorl over-riding the penultimate and one-third to one-half of the antepenultimate whorl.

Description: Shell of average size for the genus (2.5 mm. high), sinistral, ovate-cylindric. Colour very light brown or white. Whorls 4¾ to 5, sutures deeply impressed, later whorls moderately swollen. Body whorl strongly contracted behind, over-riding penultimate whorls and one-third to one-half of the antepenultimate whorl. Apical whorls 1¾,

with weak, slightly protractive radial ribs. Remaining whorls with stronger, almost regularly spaced, protractive radial ribs. Aperture circular, flaring, peristome subquadrangular, closely appressed to ante-penultimate whorl at point of attachment. Aperture with moderately developed, deeply recessed columellar tooth. Operculum without calcareous elements, deeply concave, large, without central nucleus.

Type Locality: In leaf mould behind Halavo, Florida Island, Solomon Islands (FLW 18).

Types: The holotype is University of Michigan Museum of Zoology No. 181755. Paratypes are UMMZ 200495, CNHM 55207, and BPBM 212385.

Remarks: The strongly constricted body whorl and sharp ascension of the aperture on the spire recall some of the Bismarck Island *Palaina* (see I. Rensch, 1937), but size and whorl count easily separate *P. clappi.* This species is named after William F. Clapp, who published an important paper on the Solomon Island fauna (Clapp, 1923).

Palaina megamorpha sp. nov. (Plate 6, fig. 1).

Diagnosis: A large species of *Palaina* (4.51 mm. high) with 6¾ whorls, a weak columellar tooth deeply recessed within the aperture, a very slightly expanded peristome, and the body whorl over-riding about one-half of the penultimate whorl.

Description: Shell large (4.51 mm. high), sinistral, subturriform. Whorls 6¾, sutures impressed, later whorls moderately swollen. Body whorl slightly constricted behind, over-riding to mid-point of penultimate whorl. Apical whorls 2, slightly elevated, worn. Remaining whorls with regularly spaced protractive ribs. Aperture circular, peristome only slightly expanded and thickened, reduced to a thin callus on parietal wall. Weak columellar tooth deeply recessed within aperture. Operculum not seen.

Type Locality: In leaf mould behind Halavo, Florida Island, Solomon Islands (FLW 18).

Type: The holotype is University of Michigan Museum of Zoology No. 200493.

Remarks: Possibly the only specimen seen is juvenile, and the apertural characters are greatly modified in adult shells. The size and whorl count separates this shell from any other Melanesian Diplommatinid and makes nomenclatural recognition advisable.

Family Truncatellidae.

Truncatella (Taheitia) aff. scalariformis Reeve, 1842.

FLW 32.

The single specimen is nearest to this form, but not identical.

Family Assimineidae.

Pseudocyclotus levis levis (Pfeiffer, 1855).

FLW 18, FLW 29, FLW 30, FLW 32, FLW 46.

All specimens were juvenile, about 2.5-3 mm. in height, but corresponded well in sculpture and operculum to adult shells in museums.

Omphalotropis (*Omphalotropis*) *nebulosa* Pease, 1872.

FLW 35, FLW 38, FLW 40, FLW 44.

Setaepoma mayri Clench, 1958.

Setaepoma mayri Clench, 1958, *Nat. Hist. Rennell Id.*, 2: 167-168, fig. 1, pl. 17, fig. 5 (Fulakora, Ysabel, Solomon Islands).

FLW 10.

Identification of the single juvenile specimen was confirmed by W. J. Clench. The genus *Setaepoma* (Clench, 1955) is based on *Japonia hedigeri* I. and B. Rensch (1936: 678-679, fig. 25) from Guadacanal. New Guinea species, for which Iredale (1941: 58) provided the generic names *Dominamaria, Memonella,* and *Atrocyclus,* are apparently closely related, as may be *Mychopoma exul* Moellendorff, 1897 from Constantinhaven and *M. pennatum* van Benthem Jutting (1958: 311-313, fig. 7) from Misool. All may belong to one generic unit, but more study is needed before any opinion can be given.

APPENDIX.

Collection stations of Robert E. Kuntz on Florida and Tulagi Islands.*

*Only those cited above or in Solem (1958).

ML 100. Small pool in Taro Swamp, 10-16 in. deep, 100 feet from mangroves. "MacFarlands Water Hole". January 11, 1945.

FLW 2. Swampy area near mangroves, Halavo, Florida Island. Sept. 26, 1944.

FLW 4. Around fallen trees and rocks, 300-500 feet elevation, Florida Island. October 1, 1944.

FLW 5. Rocks at edge of semi-permanent stream, south-west side of Tulagi. Sept. 15, 1944.

FLW 6. On rocks in swiftly flowing water near FLW 5. Same date and data.

FLW 8. Wet broad leaf vegetation in ravine, south-west Tulagi. Sept., 1944.

FLW 10. Behind Halavo, Florida Island.

FLW 11. Small stream south side of Tulagi. Sept., 1944.

FLW 12. Mangroves or shrubs in swamp behind Halavo, Florida Island.

FLW 13. On trees, shrubs and ground behind Halavo, Florida Island. Oct., 1944.

FLW 14. In leaves on hillside behind Halavo. Oct., 1944.

FLW 15. Ground debris, 200 feet elevation, one mile behind Halavo, Florida Island. Oct. 1, 1944.

FLW 16. Under British Residency, Tulagi. 250 feet elevation. Oct., 1944.

FLW 17. Freshwater stream in sago palm swamp, Turner City, Florida Island. Sept., 1944.

FLW 18. Leaf mould, 30 feet from stream bank, elevation 60 feet, one-half from sea behind Halavo, Florida Island. Oct. 22, 1944.

FLW 20. Under edge of hut at Halavo, Florida Island. Oct. 22, 1944.

FLW 21. Same as FLW 18.

FLW 23. From ground in low area one-quarter mile behind Halavo, Florida Island.

FLW 24. On dead logs, decaying leaves, damp rocks in shade, three-quarters mile behind Halavo, Florida Island. Elevation 300 to 500 feet, thick jungle with south-east exposure. Oct. 1, 1944.

FLW 26. On broad-leaf plants in jungle, Halavo, Florida Island. Oct. 22, 1944.

FLW 28. Same as FLW 26, but during night.

FLW 29. From shrubs and a dead tree trunk, one-half mile from beach at 100 feet elevation behind Halavo, Florida Islands. Oct. 23, 1944.

FLW 30. Under forest debris near stream, one-half mile behind Halavo, Florida Island. Oct 22, 1944.

FLW 32. Slopes of a small stream north of Halavo, Florida Island. Nov., 1944.

FLW 33. Under dead leaves on "Radar Hill", 170 feet elevation, Florida Island. Nov., 1944.

FLW 34. Pool 4-8 in. deep, 50 yds. from mangrove swamp near Hagalu, Florida Island.

FLW 35. Ground debris in plantation, on vegetation one to four feet above ground, peninsula east of Halavo, Florida Island. Nov., 1944. Elevation three feet, 20-100 feet from beach.

FLW 37. Same as FLW 34.

FLW 38. Peninsula east of Halavo, Florida Island. Nov., 1944. Under debris.

FLW 40. Soil samples from peninsula east of Halavo, Florida Island.

FLW 42. On ground in heavy jungle near Hugutambu River, Florida Island. Jan., 1945.

FLW 43. Under planks on "90 mm. Hill", Tulagi. In grassy, semi-open area.

FLW 44. Rotten sago palm trunk, 8-10 in. down in wet debris, south-west Tulagi.

FLW 45. On ginger leaves in deep shade, three feet above ground, Kokemtambu Island. Jan., 1945.

FLW 46. Under side of leaves at Hagalu, Florida Island. Jan., 1945.

FLW 47. On sand and logs along beach at low tide.

FLW 48. In mud or on roots in mangrove swamp, west end of Tulagi. Dec., 1944.

FLW 50. On mud flats or mangrove roots at low tide, Tulagi. Feb., 1945.

FLW 51. On debris in water in mangrove swamp, Hagalu, Florida Island. Feb., 1945.

FLW 52. Piles of fallen leaves and fronds in sago palm forest on Florida Island opposite west end of Tulagi. Jan., 1945.

FLW 54. Food pile in Haleta Village, Florida Island. Feb., 1945.

REFERENCES.

BAKER, H. B., 1922. Notes on the radula of the Helicinidae. *Proc. Acad. nat. Sci. Philad.*, 74: 29-67.

——— 1941. Zonitid snails from Pacific Islands. *Bull. Bishop. Mus. Honolulu,* 166: 203-370.

CLAPP, William F., 1923. Some mollusca known from the Solomon Islands. *Bull. Mus. comp. Zool. Harv.*, 65: 351-418.

CLENCH, William J., 1941. The land mollusca of the Solomon Islands (Succineidae, Bulimulidae and Partulidae). *Amer. Mus. Novit.* 1129: 21 pp., 13 figs.

———1949. Cyclophoridae and Pupinidae of Caroline, Fijian and Samoan Islands. *Bull. Bishop. Mus. Honolulu,* 196: 52 pp.

——— 1950. A new genus and species of Endodontidae from the Solomon Islands. *Rev. Soc. Malac. "Carlos de la Torre"*, 7: 59-60.

———1955. *Setaepoma,* a new genus in the Synceridae from the Solomon Islands. *Nautilus,* 68: 134.

———1958. The land and freshwater mollusca of Rennell Island, Solomon Islands. *Nat. Hist. Rennell Id.,* 2: 155-202.

COX, James C., 1870. Descriptions of seventeen new species of land-shells from the South Sea Islands, in the cabinet of Mr. John Brazier, of Sydney. *Proc. zool. Soc. Lond.,* 1870: 81-85.

DELL, R. K., 1955a. The land mollusca of Nissan Island, Solomon Islands. *Pacific Sci.,* 9: 324-331.

———1955b. A Tornatellinid land mollusk from the Solomon Islands. *Ibid.,* 9: 357-358.

———1955c. The land mollusca of the Treasury Islands, Solomon Islands. *Ibid.,* 9: 423-429.

FORCART, L., 1952. Zur Nomenklatur des Genus *Leptopoma* Pfeiffer (Cyclophoridae). *Arch. Molluskenk.,* 81: 85-86.

IREDALE, T., 1941. A basic list of the land mollusca of Papua. *Aust. Zool.,* 10: 51-94.

KOBELT, W., 1905. Review of A. J. Wagner's Helicinenstudien. *Nachr. Malakozool. Ges.,* 37: 207.

PILSBRY, Henry A., 1891. Manual of Conchology, 7 (2): 225 pp.

———and C. M. COOK, 1934. Notes on the nomenclature of Hawaiian Helicinidae. *Nautilus,* 48: 53-54.

RENSCH, Ilse, 1934. Studies on *Papuina* and *Dendrotrochus,* pulmonate mollusks from the Solomon Islands. *Amer. Mus. Novit.* 763: 26 pp.

———1937. Systematische und Tiergeographische Untersuchungen über die Landschneckenfauna des Bismarck-Archipels. II. *Arch. Naturgesch. N.F.,* 6: 526-644.

———and Bernard RENSCH, 1935. Systematische ünd Tiergeographische Studien über die Landschnecken der Salomonen. *Rev. suisse Zool.,* 42: 51-86.

———1936. Systematische und Tiergeographische Studien über die Landschnecken der Salomonen. II. *Ibid.,* 43: 653-695.

SMITH, Edgar A., 1885. On a collection of shells (chiefly land and freshwater) from the Solomon Islands. *Proc. zool. Soc. Lond.,* 1885: 588-609.

SOLEM, Alan, 1953. Marine and Fresh-water mollusks of the Solomon Islands. *Fieldiana Zool.*, 34: 213-227.

————1957. Philippine snails of the family Endodontidae. *Ibid.*, 42: 1-12.

————1958. Marine shells from Bougainville and Florida Islands, Solomon Islands. *Ibid.*, 39: 213-229.

————1959a. Marine molluscs of the New Hebrides. *Pacific Sci.*, 13: 253-268.

————1959b. Systematics and zoogeography of the land and fresh-water mollusca of the New Hebrides. *Fieldiana. Zool.*, 43: 1-359.

————1959c. On the family position of some Palau, New Guinea and Queensland land snails. *Arch. Molluskenk.*, 88: 151-158.

VAN BENTHEM JUTTING, Tera, 1958. Non-marine mollusca of the Island of Misool. *Nova Guinea* n.s., 9: 293-338.

WURTZ, Charles B., 1955. The American Camaenidae (Mollusca: Pulmonata). *Proc. Acad. nat. Sci. Philad.*, 107: 99-143.

THE OCCURRENCE OF A NEMATODE PARASITE IN THE GENUS *STYLODON*

By RUTH D. TURNER, Ph.D.,* and MADELINE A. PINI, B.A.†

Little is known concerning the presence of nematodes in molluscs, although molluscs have long been suspected of being intermediate hosts for nematodes parasitic in vertebrate animals such as sheep, cats and chickens. Previously, it has been the nematologists who were concerned with this problem, and the literature is found principally in the journals of parasitology. Chitwood (1937) and Mengert (1953) have summarized the present knowledge about the occurrence of nematodes in molluscs. Mengert reported that an examination of 1300 snails revealed 30 species of roundworms. This work was done in Germany on native material, mostly slugs. Chitwood and others have reported nematodes infesting several genera of molluscs including *Opeas, Helix, Polygyra, Anguispira, Succinea, Cepaea, Hygromia, Helicigona, Theba, Monacha,* and *Helicella* among the land snails, and *Lymnaea, Planorbis, Viviparus, Physa,* and *Bythinia* among freshwater snails. Nematodes may occur in molluscs accidentally, as parasites living their entire life cycle in the snail or as juveniles spending part of their life cycle there. It is this last group with which we are particularly concerned, for it contains species of economic importance.

Gerichter has done considerable experimental work on the life cycle of lung nematodes of sheep and cats, and has shown conclusively that at least five species of lung nematodes are dependent upon molluscs for their intermediate hosts.

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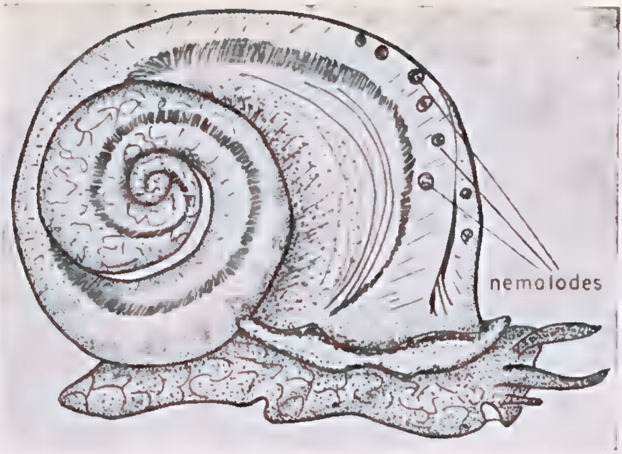


Text fig. 1.

Sketch of the animal of *Stylodon unidentata globata* v. Marts., with the shell removed, showing the location of the nematodes.

Most work of this kind has been done in areas of high population such as India and the Near East, but for much of the world the details of the mollusc-nematode relationship are unknown.

During the 1958 Yale University Expedition to the Seychelles Islands, a small collection of land shells was made, and we have been privileged to report upon this material.

While dissecting *Stylodon unidentata globata* v. Marts., we were surprised to find numerous encysted juvenile nematodes in the pulmonary cavity (Text fig 1, Plate 1, 1-2). A survey of the literature showed this to be an unusual site of infestation. Most molluscan nematodes are reported as occurring in the digestive tract or in the foot.

We immediately checked all the specimens in this lot, a series of fourteen specimens from Bois Teck, Silhouette Island, Seychelles, taken at an altitude of 800-1600 feet. Of these, six were found to be infested, with the degree of infestation ranging from one or two worms to one hundred or more per specimen. Although a careful examination was made of the entire animal, the worms were found only in the mantle cavity. Both adult and young snails were infested. A check was made of the preserved specimens of *Stylodon unidentata* Chem. and *Stylodon studeriana Fér.*, but no worms were found.

Since these worms are juveniles, it has been impossible to make a positive determination. Dr. Nathan Reiser, of Northeastern University, who examined the worms, suggested that since some of the cysts appeared to be in the process of disintegration, this snail was perhaps not the normal host; this remains to be seen. Further material is needed.

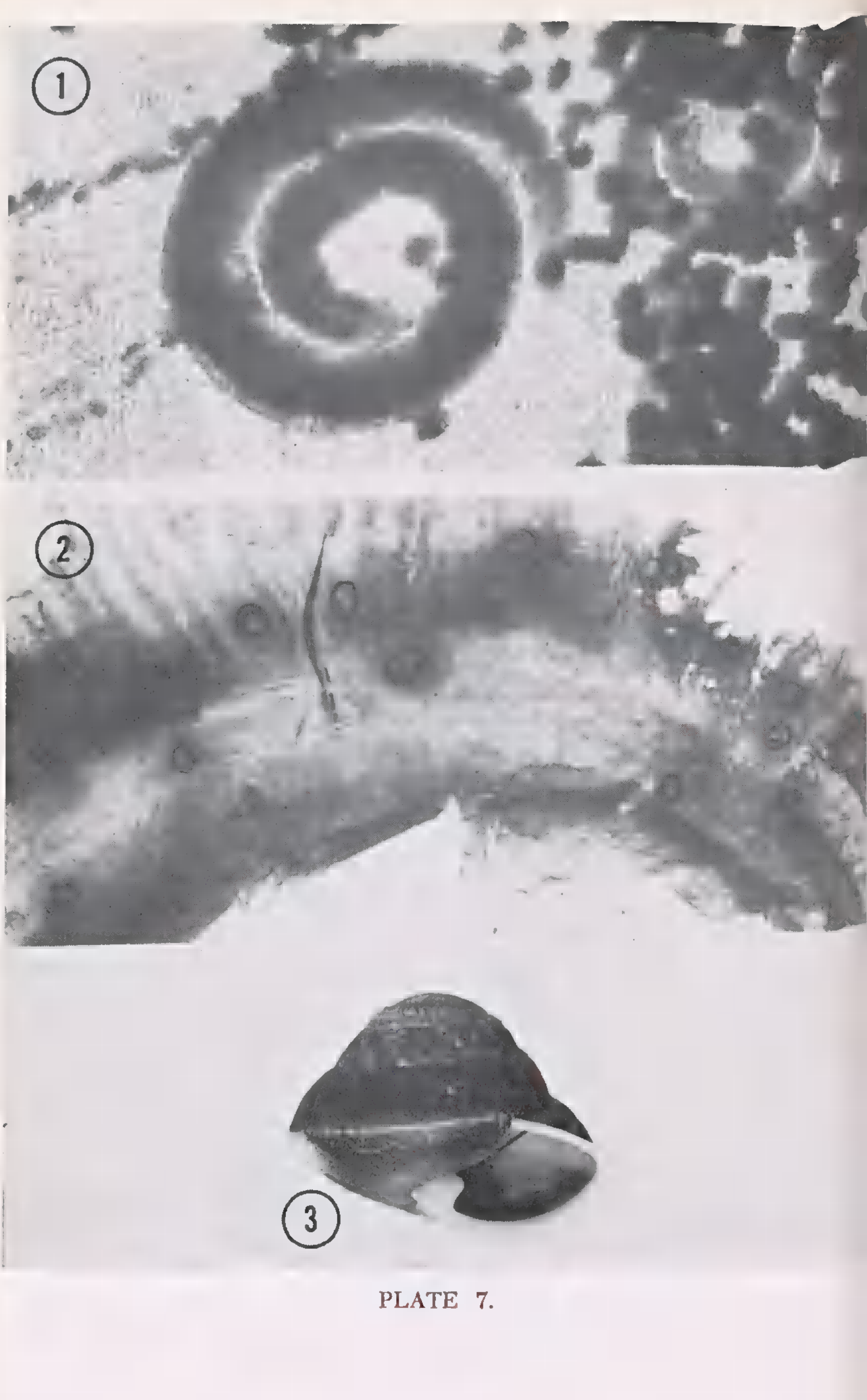


PLATE 7.

M. B. Chitwood, of the United States Department of Agriculture, who kindly consented to examine the worms, confirmed the authors' suspicions that the nematodes are probably members of the larval lungworms of the Metastrongyloida. The adults of this group parasitize mammals. Specimens of the worms have been deposited in the United States National Museum (U.S.N.M. Helm. Coll. No. 56678).

Very little is known of any nematodes from these islands, the animals which they infest, or their relationship to the roundworms of Africa and Asia. The problem is one that concerns both malacologists and parasitologists. It is here that shell collectors, both amateur and professional, can be of great assistance. As several writers have pointed out, thousands of animals may be examined in vain by the eager nematologist, while the unsuspecting malacologist innocently throws away the soft parts of the snails, and with them the precious nematodes.

A few minutes spent in examining the animal will prove not only helpful to the parasitologist, but also interesting for the collector. If one suspects that he has an infected animal, it should be placed in 75% alcohol and sent with a specimen of the shell to the authors, who will see that it is forwarded to the nematologist mentioned above.

REFERENCES.

CHITWOOD, B. G., and CHITWOOD, M. B., 1937. Snails as hosts and carriers of nematodes and nematomorpha. *Nautilus,* 50: 130-135.

FRÖMMING, E., 1955. Land gastropods as carriers of human illness. *Kosmos, Stuttgart,* 51: 535-537.

GERICHTER, C. B., 1948. Snails as intermediate hosts of nematodes. *Amer. J. vet. Res.* 9: 109-112.

————1949. Studies on the nematodes parasitic in the lungs of Felidae in Palestine. *Parasitology,* 39: 251-262.

MENGERT, H., 1953. Nematoden und schnecken. *Z. Morph. Ökol. Tiere,* 41: 311-349.

MICHELSON, E. H., 1957. Studies on the biological control of schistosome-bearing snails. *Parasitology,* 47: 413-426.

PELSENEER, P., 1928. Les parasites des mollusques et les mollusques parasites. *Bull Soc. zool. Fr.* 53: 158-189.

WATSON, J. M., 1960. Medical helminthology (Balliere, Tindall & Cox, London).

PLATE 7.

Stylodon unidentata globata v. Marts.

1. Encysted nematode in the wall of the pulmonary cavity. 90x.
2. Section of nematode-bearing tissue from the pulmonary cavity. 20x.
3. The infected snail (MCZ No. 225927). Natural size.

VARIATIONS IN AN AUSTRALIAN HALIOTID, *HALIOTIS COCCORADIATA* Reeve, 1846

By R. R. TALMADGE.*

For a number of years malacologists have commented on the variation in the sculpture and colouration of *Haliotis coccoradiata* Reeve, 1846, inhabiting the south-eastern coast of Australia. In this summary the genus *Haliotis* is used in the broadest sense (*sensu lato*), as anatomical evidence suggests that our present classification at the generic level needs revision. Rather than digress into a study of the higher classifications on a study restricted to a single species, the well-known *Haliotis* will be used.

As a number of specimens were available to the writer, from localities that could be plotted on a large scale map, it was thought that perhaps some answer might be found for the variations which had been observed. The following notes are the result of this comparative investigation.

Eighty specimens were made available for examination, as well as those in the collections of the museums and universities on the coast of California. However, the basic study is restricted to the eighty specimens, ranging from 10 mm. to 60 mm. major diameter, eleven of which contained the soft parts for comparison and dissection. The majority of these specimens were taken within a few miles of Sydney, thus presenting a good representation of this population of the species. Series such as these give a much clearer concept of the species, as the age stages, pathological specimens, and colour variations are more readily identified as such. The animal in combination with the shell presents a check on the possible separation at a species level, as well as providing a means of determining if sexual differences cause variation in the shell.

Nearly all the specimens had a similar shape, regardless of age stages, so the shape of the shell was ruled out for comparative purposes.

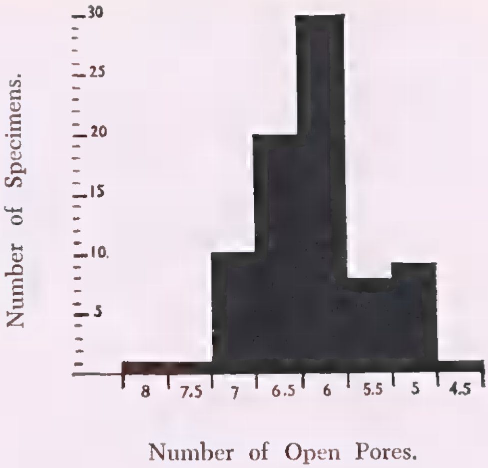
Other than colouration, there were found to be two distinct and notable variables: the number of open siphonal pores (which is given great status by Reeve (1846a); and the sculpture.

Open Siphonal Pores: In the series examined, the number ranged from 4½ to eight, with sixty (75%) of the specimens having 6 to 7 (Text fig. 1). The number of orifices could not be attributed to age stages, as both the smallest and largest specimens had six each. The evidence indicates that the number of such openings is dependent upon the individual animal.

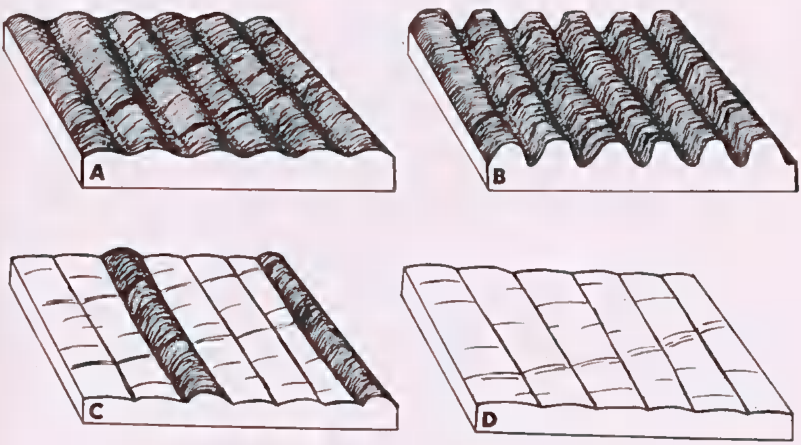
Sculpture: This was found to exhibit considerable variation, which could not be correlated with any age stage. The shell, in most cases, is covered with a series of rather uniform cords, which under a strong glass, give a scale-like appearance. There are low rounded wrinkles, radiating from the suture in the upper third of the body whorl.† The chief variation is in the cording, which may be divided into four types and which merge from one into the other (Text. fig. 2). The most common

†One example was noted to have these wrinkles developed into actual lamellae, but this shell was pathological in other features also.

*Willow Creek, California, U.S.A.



Text fig. 1.



Text fig. 2 (Diagrammatic).
Types of sculpture.

(Text fig. 2 A) was a rather uniform, rounded thread, more or less equally spaced across the shell. This blended into the second type (Text fig. 2 B), which had enlarged and sharply defined cords. These enlarged cords were quite striking, and gave the specimens almost a separate specific appearance. The third type (Text fig. 2 C), a much less common sculpture, consisted of a single, rather coarse cord, widely spaced on a nearly smooth shell surface. Under a glass, obsolete cording could be seen in the semi-smooth areas. The fourth type (Text fig. 2 D) was a nearly smooth surface which gave no indication of wear or erosion, only obsolete striae. These last two types of sculpture, like the coarsely corded form, were quite notable. This was true in the specimens that had the sculpture in the pure form, but the numerous intermediate shells formed a perfect intergradational series.

Colouration: This varies so much that it would be impossible to describe in any detail the numerous phases. As the colour charts of Ridgeway and others are not available to all students, only general terms will be used. It was found that no two specimens were alike. The basic colours were a rich red-brown, white, cream, or light green. These were boldly splotched over the surface of the shell, the radiating markings shown in the original illustrations not being found in many cases. Some specimens, instead of having the bold maculations, had the colouration subdued and blurred into more or less pastel tints. A few specimens were nearly concolour.

The various series were then sorted as to locality in an effort to co-ordinate the colouration, sculpture and number of open pores, to a localized ecological condition. It was found that regardless of the collecting station, these same variations occurred in all series.

The animals were examined to learn if sex, as determined by the colour of the gonad, should be used as a factor to correlate the variations observed in the shell. The answer was negative. From the study of the epipodium, *H. coccoradiata* may be placed into the major groupings of the haliotids. This is separable from the minor anatomical groupings of *H. asinina* Linné, *H. cyclobates* Peron and *H. sanguinea* Hanley; that is, the animal may be contained within the shell, the epipodium forms a nearly continuous fleshy girdle encircling the foot, and has both an upper and lower rim. The thickened area between the rims is processed. No two species are alike in this group, but all have a general similarity.

The data thus indicate that *H. coccoradiata* is a quite variable species in the number of open pores, cording and shell colouration. The animal remains constant. These variations cannot be explained as the result of age stages, sexual or localized ecological conditions. The only remaining cause would be on the individual genetic basis. A similar situation exists in the Canary Islands, where a single species also exhibits similar variations (Talmadge, 1958).

To validate the identification of certain material, selected specimens and some series were sent to the British Museum (Natural History) for comparison with the original material used by Reeve in the Hugh Cuming Collection. The basic and most common specimens matched the named series, while the coarsely corded specimens fit into the type lot of *H. lauta* Reeve, 1846. The original description of this last species placed the range in Western Australia. *H. lauta* Reeve has been placed as a synonym

of *H. semiplicata* Menke, 1843, by some authors. These recent comparisons now leave the status of *H. lauta* open to further study.

The writer wishes to express his deep appreciation to Dr. D. F. McMichael, of the Australian Museum, Sydney; Mr. S. P. Dance, of the British Museum (Natural History); Dr. Leo Hertlein, of the California Academy of Sciences, and Dr. Myra Keen, of the Stanford University, California, as well as to the many private collectors in Australia who assisted with specimens, literature and field data. Without this co-operation and assistance, this portion of the general study of the haliotids could not have been carried out.

REFERENCES.

MENKE, C. T., 1843. Molluscorum Novae Hollandiae. *Specimen*, p. 32.

REEVE, L., 1846a. Conchologia Iconica. 3: (*Haliotis*), pl. 13, fig. 46, pl. 17, fig. 68.

————1846b. Haliotis. *Proc. zool. Soc. Lond.*, Pt. 14: 58.

TALMADGE, R. R., 1958. The Canary Island Haliotid. *Nautilus*, 72: 55-58.

ON *TYLODINA CORTICALIS* (Tate), A RARE OPISTHOBRANCH FROM SOUTH-EASTERN AUSTRALIA

By ROBERT BURN.*

Tylodina corticalis (Tate 1889, pp. 65-66) is a rare south-eastern Australian opisthobranch gastropod. Its discovery in the living state is unusual; the time of the year during which it has been found alive (March-April) apparently corresponding to the breeding period. It has a vertical range from the littoral and sub-littoral to 7-16 fathoms (Tate, loc. cit.) to 30 fathoms (Bass Strait trawlings: specimens in the collection of Mrs. D. I. Hartley, Melbourne).

The recent finding of two living specimens allows a fuller description of both shell and animal to be compiled. The writer must express his thanks to Miss F. V. Murray, of Melbourne, for making available the larger of the two specimens, and to Miss J. H. Macpherson, National Museum of Victoria, Melbourne, for the loan of a series of kodachrome slides made from this specimen while alive.

TYLODINA CORTICALIS (Tate, 1889).

Umbrella corticalis Tate 1889, p. 65, pl. 11, fig. 11.
Umbraculum corticalis Cotton and Godfrey 1933, p. 97, pl. 1, fig. 22.
Umbraculum corticalis Macpherson and Chapple 1951, p. 140.
Tylodina corticalis Burn 1959, p. 28, fig. *d*.

The larger living specimen (Text fig. 1) was 50 mm. long, about 35 mm. broad, and 12 mm. high; preserved it is 20 mm. long, 15 mm. broad, and 10 mm. high. The smaller specimen alive was 22 mm. long, 11.5 mm. broad, and 5 mm. high; preserved it is 10.5 mm. long, 8 mm. broad, and 5.5 mm. high. The shell covers only the gill, the basal parts of the rhinophores and the body or visceral hump; the foot protrudes in front and behind; the head with the eyes and oral tentacles extends forward over the anterior foot.

The whole animal is either ochraceous yellow or brilliant lemon yellow. The interstices of the foot patterning are whitish; the anterior edges of the foot, the rhinophores and the skin over the pharyngeal bulb are orange. The mantle is pale creamy-yellow, darker at the margins. The sides of the body are white; the gill is yellow. In both alcohol and phenoxotol preservatives, the yellow pigment of the skin precipitated, and the animals are now drab blue-gray or purple; this corresponds to Tate's statement (1889, p. 66) that the "animal is of a deep port-wine colour".

The shells (Text figs. 4, 5) are very broadly oval in shape and nearly flattened. Inclusive of the periostracum they measure respectively 29 x 25 x 3.5 mm. and 12.5 x 11 x 2.7 mm. in length, breadth and height. The shell proper in each case measures 19 x 16 x 2 mm. and 8.5 x 7 x 1.3 mm., and is very thin and fragile with razor-sharp edges. The corneous periostracum is thin about the protoconch and thick at the margins; it spreads completely over the shell and extends well beyond it, but not as far as Tate (loc. cit. p. 65) indicated. There are thirteen radial ridges on the larger shell and eleven on the smaller one; Tate (loc.

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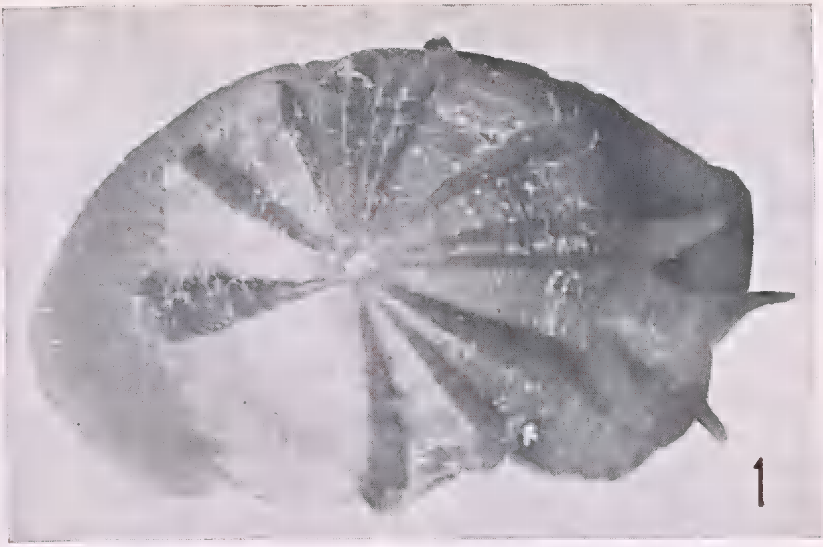
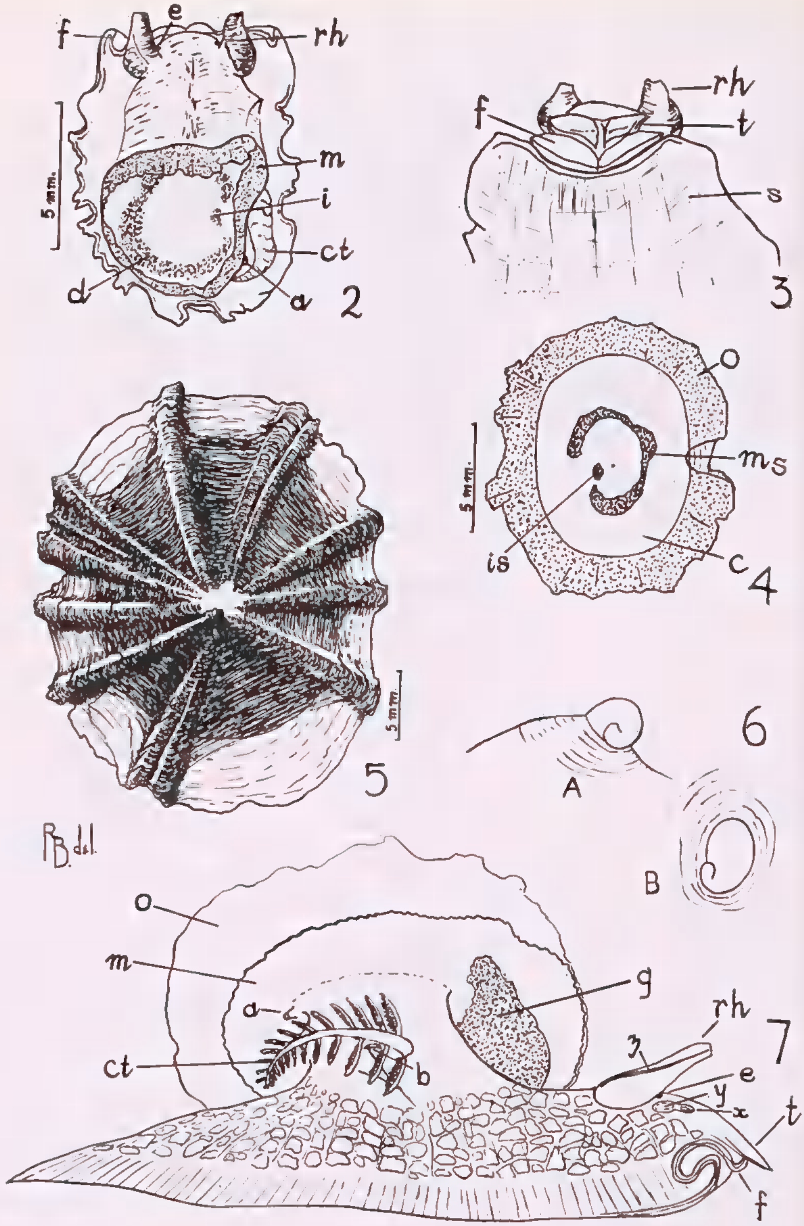


Text fig. 1.

Tylodina corticalis (Tate). Photograph of living specimen. (Nat. Mus. Vic. No. F21276). (x 2).

cit., p. 65) indicated "about 20 broad rays" on the type. The ridges are dark brown and are hollow on the undersides at the margins, but are built up and filled in before the shell proper is reached. The dorsal sides of the ridges bear a few (3-8) simple spurs or horns representing rest periods during growth. The periostracum contains a number of sand grains in its structural composition; it is pale red-brown in colour. The shell proper shows through the periostracum as an olive-green area; ventrally it is nacreous; within the muscle scars it is yellow; the scars are silver or translucent and the remainder is white. The protoconch (Text fig. 6) comprises 1½ whorls; it is sinistral, white and entirely smooth; it measures about 0.4 mm. long and 0.25 mm. broad.

The anterior border of the foot is thickened and carries a shallow groove within the thickening; it is notched in the mid-line; the anterior folds (*f*) are characteristic of the species. At the level of the genital apertures the foot turns upwards for a short way, then folds backwards, upwards and forwards until it curls downwards under the oral tentacles. Ventrally, the anterior part of the sole is shallowly concave, and this concavity is filled with the thickened anterior of the foot. The sole of the foot (*s*) is longitudinally striated with shallow muscular furrows. The tail is flat and broadly rounded behind. The foot marginal surface has very low raised lines which radiate out from the body: inside this lined area the skin is raised into low scale-like plates which more or less form lines in conjunction with the marginal raised lines.



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Text figs. 2-7.

The mantle (m) is thin and tough, with edges thickened and nodular; its surfaces are entirely smooth; Tate (loc. cit., p. 66) records small white caruneulae on the underside (these are possibly the result of some infestation of marine parasites). When expanded the mantle reaches to the edge of the periostracum. Contained in the mantle in front of the body is a large chocolate-brown crescent-shaped gland (g) which is here termed the pre-mantle gland. The anterior edge of this gland is thick, while near the body it is thin and patchy. No secretions from the gland were observed in the living animals. The rhinophores (rh) are large and distinctive; their bases are narrow, as are the tips, while mid-laterally they are swollen and slit (z). The eyes (e) are black and are situated in front of and between the rhinophores. The oral tentacles (t) are short, narrow and latero-ventrally slit; on the median side they meet in a shallow notch between two tumid swellings. The genital apertures are contiguous; the larger female one (y) is behind the smaller male one (x), and they are situated on the ridge between the rhinophore and oral tentacle on the right side.

The gill (ct) is a very elegant plume originating high up under the mantle about half way along the right side of the body. There are twelve alternately placed pinnae each side of the smooth rounded gill rhachis. Each pinna has ten or twelve minute short pairs of whitish feather-like pinnulae. The gill is attached for about half its length; in the larger preserved specimen it is 15 mm. long and is attached for 8 mm.; in the smaller specimen it is 4.2 mm. long and is attached for 1.8 mm. The anus (a) opens at the top of a short stout papilla above and behind the junction of the gill attachment and the body wall. Below the anterior of the gill rhachis is a deep cleft or indentation in the body wall, at the anterior top of which is a slit-like opening into a shallow cavity (b), the sub-branchial aperture, which is probably analogous with the pre-branchial aperture (of Bourne's gland) of the Pleurobranchacea. The columella muscle (d) of the visceral hump shows as a glossy pad around the black viscera, and there is a small flatly triangular intermediate suspensor muscle (i) on the right side at the level of the gill. The columellar muscle forms an incomplete ring around the visceral hump, there being a short gap between either end of it and the suspensor muscle (Text fig. 4 *is*, *ms*, and Burn 1959, fig. *d*, both show these gaps between the muscles, but in reverse as the undersides of the shells are figured).

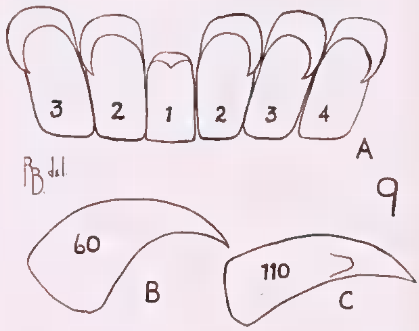
Text figs. 2-7.

2. Smaller preserved animal from above: shell removed.
3. Anterior part of same specimen as fig. 2 from below.
4. Smaller shell from below.
5. Larger shell from above.
6. Protoconch of Aust. Mus. specimen No. C.62263. A, left lateral side. B, from above.
7. Sketch of living animal from right side.

a, anus. *b*, sub-branchial aperture. *c*, shell proper. *ct*, gill. *d*, columellar muscle. *e*, eye. *f*, anterior folds of foot. *g*, pre-mantle gland. *i*, intermediate suspensor muscle. *is*, intermediate suspensor muscle scar. *m*, mantle. *ms*, columellar muscle scar, *o*, epidermis. *rh*, rhinophore. *s*, sole of foot. *t*, oral tentacle. *m*, male aperture. *y*, female aperture. *z*, rhinophoral slit.

The pharyngeal bulb of the smaller specimen only was examined; it measures 3.6 mm. long, 2.4 mm. broad, and 3 mm. high. There is a small, thin jaw plate (Text fig. 8) present in front of the radula measuring 2 mm. in height, the upper pale purple part of which is rounded and fan-shaped with approximately 42 denticulations (muscle hold-fasts) spread evenly along the upper margin. From between these denticulations run shallow furrows in irregular converging courses towards the smooth-edged mouth-opening which is between two thickened purple parts, each with an upper and lower nodular ridge. The radula (Text fig. 9) is pale orange in colour, and is 3.9 mm. long and 1.8 mm. broad; the formula is 84 x 130.1.130. The rhachidian (*1*) is smaller than its laterals (*2, 3, 4*), although there is very little difference in shape. Each tooth has a single cusp with a small flange-like denticle on the inner side which articulates with the cusp of the next. The half rows of teeth meet at the rhachidian in a near straight line, which is as Odhner states for *T. rafinesquei* = *T. citrina* (1939, p. 15).

Text fig. 8.
Jaw plate.



Text fig. 9. Radular teeth. (x 325).
A. Rhachidian and immediate laterals.
B. Lateral tooth from outer side.
C. Outer lateral tooth from inner side.

The genital organs have not been examined.

Occurrence and *Localities:* One specimen (Nat. Mus. Vic. F21275) crawling on weed in a deep rock pool at the outer edge of the reef, Ocean Beach, Flinders, Victoria, 20/3/1960, coll. R. Burn; one specimen (Nat. Mus. Vic. F21276) left on rock platform by receding tide, Ocean Beach, Portsea, Victoria, 3/4/1960, coll. Miss F. V. Murray. Both specimens have been presented to the National Museum of Victoria, Melbourne.

Discussion: The known range of *T. corticalis* is from the gulfs of South Australia eastwards through Victoria and northwards to Sydney Harbour, N.S.W. A specimen in the Australian Museum, Sydney (No. C.62263) provides the first record of the species from that State, and also the most northerly record to date. It was "taken alive off Sydney (? Heads) by skin-divers, January, 1957"; no other information is available. The protoconch illustrated in Text fig. 6 is that of this specimen.

That this species is a *Tylodina* is beyond doubt, the examination of the animal validating the author's earlier arguments (Burn 1959, pp. 28-29) for this generic placement. The criteria used by Odhner (1939, pp. 14-15) to differentiate between *Tylodina* Rafinesque, 1819, and *Tylodinella* Mazzarelli, 1897, when applied to *corticalis* Tate indicate clearly that it belongs to *Tylodina,* and not *Tylodinella.* Briefly these criteria of *Tylodina* are: (1) animal larger than shell and not capable of retraction within it, (2) eyes in front of level of rhinophores and not behind them, (3) presence of rhachidian in radula, and (4) articulation of teeth instead of separation, and (5) presence of an intermediate suspensor muscle between the ends of the columellar muscle.

There are at least three valid species of *Tylodina* throughout the world. They are *T. corticalis* described above, *T. citrina* (Joannis) the type of the genus from western Europe, north-western Africa and the Mediterranean, and *T. fungina* Gabb from California. *T. corticalis* is very similar in the shape of the shell and in the animal to *T. citrina,* but the radial ridges of the periostracum and a different radular formula in the former, appear to separate the two species. *T. fungina* has not been anatomically described to date other than for the figure of the shell muscle scars (Burn 1959, fig. *c*).

Tylodina alfredensis Turton, 1932, from Port Alfred, South Africa, is placed in this genus after examining the muscle scars visible in the type photograph; these scars hardly differ in shape from those of *T. corticalis,* and if the animal could be compared with the present species it might prove to be identical.

REFERENCES.

BURN, R., 1959. Comments on the Australian Umbraculean Mollusca. *J. malac. Soc. Aust.,* 3: 28-30.

COTTON, B. C., and F. K. GODFREY, 1933. South Australian shells, pt. vii. S. *Aust. Nat.,* 14 (3): 72-108, pl. 1-4.

MACPHERSON, J. H., and E. H. CHAPPLE, 1951. A systematic list of the marine and estuarine Mollusca of Victoria. *Mem. Nat. Mus. Vict.,* 17: 140.

ODHNER, N. H., 1939. Opistrobranchiate Mollusca from the western and and northern coasts of Norway. *K. norske vidensk. Selsk. Skr.* 1939, No. 1: p. 93.

TATE, R., 1889. Descriptions of some new species of marine Mollusca from South Australia and Victoria. *Trans. Roy. Soc. S. Aust.,* 11: 60-66, pl. 11.

NOTES AND RECORDS

A Large Specimen of *Notodarus gouldi* (McCoy, 1888).

During a recent trip to the Eyre Peninsula, South Australia, Mr. V. Rogers showed me photographs of himself holding a large squid which he found beached at Fiddlers Bay, some eight miles south of Tumby Bay, in 1956. The squid could be identified as *Notodarus gouldi* (McCoy), or Gould's Calamary. Unfortunately, the tentacles were missing, most likely having been torn off by birds, but the remainder showed that the animal was very large, in life probably being over four feet long. This is about twice the normal length of the species, and would be the largest specimen yet recorded from South Australia.

—B. C. Cotton, South Australian Museum.

Notes on *Zoila thersites* (Gaskoin, 1849).

A well developed ledge (expanded base) is a common character of all shells taken from the Sir Joseph Banks Group, Spencer's Gulf, South Australia. In a series in the South Australian Museum from other localities, some specimens show a slight development of this ledge, thus indicating that those from the Sir Joseph Banks Group represent an ectotype rather than a distinct variety.

During a recent search in this area, Mr. Alan Rogers brought to the surface a fine specimen of Z *thersites,* with its mantle extended over the edges of a single valve of a Queen Scallop, *Equichlamys bifrons,* in which it had spawned. The egg capsules, deposited in a gelatinous mass, were golden yellow in colour, round and about 5 mm. in diameter. Several juveniles in the bulla stage were observed during the year, the animals of which were a bright saffron yellow, contrasting with the black of the adult.

—W. P. Trenberth, Tumby Bay, South Australia.

Recently I saw a very fine range of *Zoila thersites* taken from the Gulf of St. Vincent side of Yorke Peninsula, South Australia, and noticed that they were definitely smaller than those from the Sir Joseph Banks Group, on the other side of the Peninsula in Spencer's Gulf; also in general colour they were a deeper shade of brown. All were inhabiting approximately the same depth of water—about 12 to 25 feet according to the tide at the time of taking.

—R. A. Hall, Prospect, South Australia.

New Names for two Victorian Opisthobranch Molluscs.

1. The name *Melibe pellucida* Burn, 1957, *J. malac. Soc. Aust.,* 1: 24, has been found to be preoccupied by *M. pellucida* Bergh, 1904, which is synonymous with *M. leonina* (Gould, 1853) from the Atlantic coast of North America, therefore the name *M. maugeana* is now proposed for the Victorian species in place of the homonym.

2. *Cyerce nigra pallens* Burn, 1957, *J. malac. Soc. Aust.,* 1: 14, proves not to be a *Cyerce* Bergh, 1871 (= *Lobifera* Pease, 1866, vide Pruvot-Fol, 1947, *J. Conchyliol.,* 87 (3): 100-104) since it does not have the transversely divided foot of the genus. The Victorian species is probably a *Branchophyllum* Pruvot-Fol (loc. cit.), although this genus has an entire but very much narrower foot than the present species. Nevertheless it is better to place the species in this genus, and it will now be known as *Branchophyllum pallens* (Burn).

—R. Burn, Geelong West, Victoria.

INSTRUCTIONS TO AUTHORS

1. It is the responsibility of authors to prepare papers in a form suitable for publication, and they should consult a current issue in order to familiarize themselves with the practices of the *Journal.*

2. No paper shall be published unless approved by the Editor and the Committee.

3. Upon acceptance for publication, the paper, including plates, maps, diagrams and photographs, and all copyrights thereof, become the property of the Society.

4. Papers should be in double-spaced type-script on one side of the paper only, with a 1½" margin. The author's name should appear underneath the title with a footnote indicating the address of the institution (if any) to which he belongs and any necessary acknowledgment. A summary should be included. The original type-script and one carbon copy should be forwarded.

5. As a standard for spelling, the *Journal* uses the *Concise Oxford Dictionary of Current English* (1951, Oxford: Clarendon Press).

6. References should be cited in the text by the year of publication, e.g. Guiler (1950) or—if there are several publications by the same author and in the same year—Guiler (1953a, 1953b), and are to be arranged at the end of the article in the alphabetical order of the authors' names. E.g.

   Guiler, E. R., 1950. Intertidal classification in Tasmania. *J.Ecol.,* 41: 87-92.

   References to books should give the year of publication, the number of the edition, the town of publication, and the name of the publisher. Abbreviations of titles of periodicals should conform with those used in *A World List of Scientific Periodicals* (1952, 3rd ed., London; Butterworth). (This *Journal: J. malac. Soc. Aust.*)

7. Symbols and abbreviations should conform with those recommended in the Royal Society's publication, *General Notes on the Preparation of Scientific Papers* (1950, Cambridge University Press), e.g., all names which are to be printed in italics (such as generic and specific names) must be underlined in the type-scripts.

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12. Descriptions of new species or lesser taxa should not be submitted unless arrangements have been made by the author for depositing the holotype with a recognised public Museum, and Museum numbers of the type specimens included in the manuscript. Type localities should be defined as accurately as possible with geographical longitudes and latitudes added.

13. The Editor reserves the right to make literary amendments.

14. Reprints are obtainable by previous arrangement with the Editor and are charged to the author.

"Easy writing's curst hard reading."—*Richard Brinsley Sheridan.*

"Easy reading's curst hard writing."—*The Editors, J. gen. Microbiol.*

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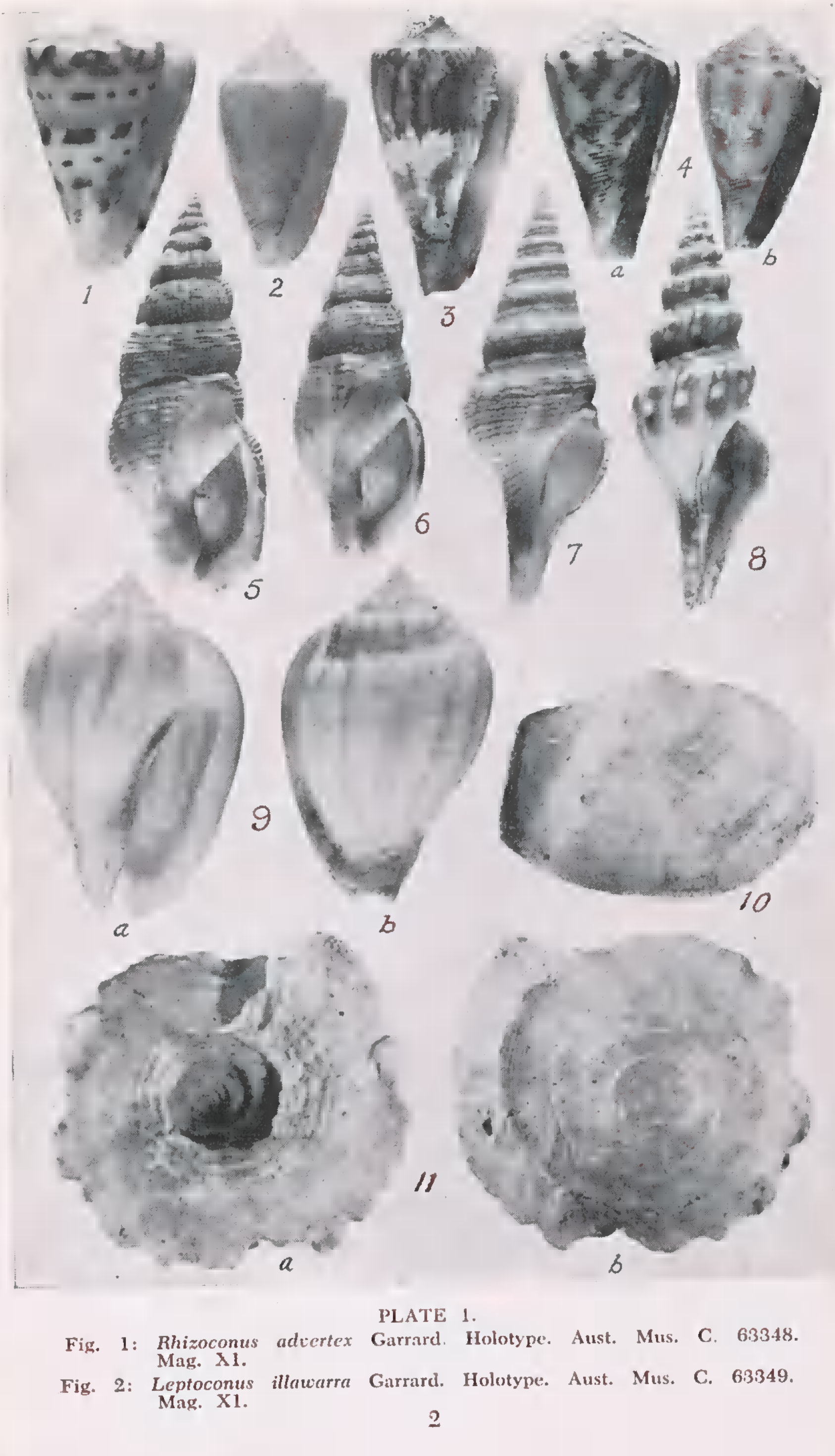

PLATE 1.

Fig. 1: *Rhizoconus advertex* Garrard. Holotype. Aust. Mus. C. 63348. Mag. X1.

Fig. 2: *Leptoconus illawarra* Garrard. Holotype. Aust. Mus. C. 63349. Mag. X1.

MOLLUSCA COLLECTED BY m.v. "CHALLENGE" OFF THE EAST COAST OF AUSTRALIA

By T. A. GARRARD.*

SUMMARY.

A systematic list of the mollusca obtained during the prawn surveys carried out off the east coast of Australia by m.v. "Challenge" on behalf of the Commonwealth Fisheries Office is given; sixteen new species are described, and three new generic names are introduced.

INTRODUCTION.

A survey of the eastern coast of Australia covering most of the continental shelf and also parts of the continental slope down to 170 fathoms, was carried out by m.v. "Challenge" in a search for new prawning grounds from July to December 1957, February to August 1958, February to August 1959, and November 1959 to May 1960, under the auspices of the Commonwealth Fisheries Office, Canberra.

The area covered extended from Bass Strait to Cairns in Queensland, and unfortunately it is understood that no new prawning grounds of any consequence were discovered. However the quantity of marine life brought up by the nets was considerable, and it is a matter for great regret that two or three scientific workers were not on board throughout the surveys for the purpose of general collecting.

Unfortunately the author had no knowledge of the undertaking until the third survey was well under way, and therefore the bulk of the material obtained came from the area covered between Newcastle and Port Kembla, when the vessel berthed on several occasions in Port Jackson. Very little co-operation was obtained in securing material, and despite promises the fourth survey yielded only a handful of shells. However Dr. Racek of the Department of Zoology, Sydney University, spent a short period on board and managed to obtain some useful specimens, and some others have been obtained through the agency of Mr. D. Gates, all of which have been shared between the Australian Museum, Sydney, and the National Museum of Victoria, Melbourne. It was considered that the

*3 The Circle, Dundas, N.S.W.

Fig. 3: *Floraconus wallangra* Garrard. Holotype. Aust. Mus. C. 63323. Mag. X1.

Figs. 4a, 4b: *Mamiconus minnamurra* Garrard. Holotype. Aust. Mus. C. 63350 (a), and paratype (b). Mag. X1.

Fig. 5: *Colubraria fantomei* Garrard. Holotype. Aust. Mus. C. 63346. Mag. X2/3.

Fig. 6: *Colubraria myuna* Garrard. Holotype. Aust. Mus. C. 63347. Mag. X1.

Fig. 7: *Turris binda* Garrard. Holotype. Aust. Mus. C. 63351. Mag. X2/3.

Fig. 8: *Turricula murrawolga* Garrard. Holotype. Aust. Mus. C.63352. Mag. X1.

Figs. 9a, 9b: *Pulchroniscia delecta* Garrard. Holotype. Aust. Mus. C. 63343. Mag X1.

Fig. 10: *Thracidentula perulae* Garrard. Holotype. Aust. Mus. C. 63340. Mag. X1.

Figs. 11a, 11b: *Russetia dilaniatus* Garrard. Holotype. Aust. Mus. C. 63345. Mag. X1.

quantity secured warranted the compilation of a systematic list in order to give a better idea of the distribution of some of the species found and add further data regarding some of them, whilst the discovery of no less than sixteen new species has given considerable added value to this record. All localities mentioned are indicated in the map on page 37.

The systematic arrangement here followed is largely that used in the "Reference List of the Marine Mollusca of New South Wales" by Tom Iredale and Donald F. McMichael, at present in press, and to a manuscript copy of which the present author had access, and thanks are extended to them for their invaluable assistance in searching records and checking of references.

SYSTEMATIC LIST OF SPECIMENS

CLASS PELECYPODA (LAMELLIBRANCHIA)

SUBCLASS PRIONODESMACEA

FAMILY NUCULIDAE

ENNUCULA Iredale 1931, Rec. Aust. Mus. 18, p. 202, type species by original designation *obliqua* Lamarck.

obliqua Lamarck 1819, Hist. Anim. s. Vert., 6 (1), p. 59.

One live specimen in 65 fathoms east of Broken Bay.

FAMILY LIMOPSIDAE

VERSIPELLA Iredale 1931, Rec. Aust. Mus., 18, p. 203, type species by original designation *soboles* Iredale.

soboles Iredale 1931, Rec. Aust Mus., 18, p. 203.

Two single valves in 90-100 fathoms east of Tuggerah; one live specimen off Broken Bay; ten live specimens east of Botany Bay in 60 fathoms; three live specimens in 45-75 fathoms east of Port Kembla.

SENECTIDENS Iredale 1931, Rec. Aust. Mus., 18, p. 204, type species by original designation *dannevigi* Iredale.

dannevigi Iredale 1931, Rec. Aust. Mus., 18, p. 204.

Ten live specimens in 160 fathoms east of Newcastle; eight live specimens in 75 fathoms east of Broken Bay; five live specimens in 60 fathoms east of Stanwell Park.

FAMILY ARCIDAE

DESTACAR Iredale 1936, Rec. Aust. Mus., 19, pp. 268, 334, type species by original designation *metella* Hedley.

metella Hedley 1917, Proc. Linn. Soc., N.S.W., 41, p. 681, pl. 51, figs. 36, 37.

One live specimen off Broken Bay; a quantity of live specimens in 45 fathoms east of Botany Bay.

FAMILY GLYCYMERIDAE

VELETUCETA Iredale 1931, Rec. Aust. Mus., 18, p. 203, type species by original designation *flammea* Reeve.

thackwayi Iredale 1931, Rec. Aust. Mus., 18, p. 203.

One live specimen in 50 fathoms east of Botany Bay.

FAMILY TRIGONIIDAE

NEOTRIGONIA Cossman 1912, Ann. Paleont., 7, p. 81, type species by monotypy *margaritacea* Lamarck.

lamarckii Gray 1838, Ann. Nat. Hist., (1), p. 482.

Two live specimens in 45 fathoms east of Broken Bay; one live specimen in 37-40 fathoms east of Barrenjoey Light; two single valves in 50 fathoms east of Botany Bay.

gemma Iredale 1924, Proc. Linn. Soc. N.S.W., 49, p. 193, pl. 33, figs. 1, 2, Pl. 35, f. 1.

Nine single valves in 45 fathoms east of Broken Bay.

FAMILY PECTINIDAE

MESOPEPLUM Iredale 1929, Rec. Aust. Mus., 17, p. 162, type species by original designation *caroli* Iredale.

caroli Iredale 1929, Rec. Aust. Mus., 17, p. 162, pl. 38, f. 7-9.

A number of live specimens taken in depths from 25 to 60 fathoms from Newcastle Bight to Bass Strait.

MIMACHLAMYS Iredale 1929, Rec. Aust. Mus., 17, p. 162, type species by original designation *asperrima* Lamarck.

asperrima Lamarck 1819, Hist. Anim. s. Vert., 6 (1), p. 174.

One live specimen in 30 fathoms east of Twofold Bay.

NOTOVOLA Finlay 1926, Trans. New Zeal. Inst., 57, p. 451, type species by monotypy *novaezealandiae* Reeve.

fumata Reeve 1852, Conch. Icon., 8, pl. 9, f. 32.

Fairly plentiful in all depths up to 100 fathoms, and on all parts of the coast from Port Stephens southward to Bass Strait.

FAMILY AMUSIIDAE

AMUSIUM Röding 1798, Mus. Bolten, pt. 2, p. 165, type species by tautonymy *pleuronectes* Linne.

ballotti Bernardi 1861, J. de Conch., 9, p. 46, pl. 1, f. 1.

One live specimen in 27-35 fathoms east of Broken Bay; considerably darker red in colour than specimens commonly found in southern Queensland.

FAMILY DIMYIDAE

DIMYARINA Iredale 1936, Rec. Aust. Mus., 19, p. 269, type species by original designation *corrugata* Hedley.

corrugata Hedley 1902, Mem. Aust., Mus., 4, p. 308, f. 52.

Found alive in fair numbers in 40-50 fathoms east of Botany Bay.

FAMILY OSTREIDAE

OSTREA Linne 1758, Syst. Nat. ed. 10, p. 696, type species by subsequent designation (Gray 1847, Proc. Zool. Soc. Lond. 1847, p. 201) *edulis* Linne.

? *nomades* Iredale 1939, Great Barrier Reef Exp., p. 395, pl. 7, f. 1, 1a, 1b.

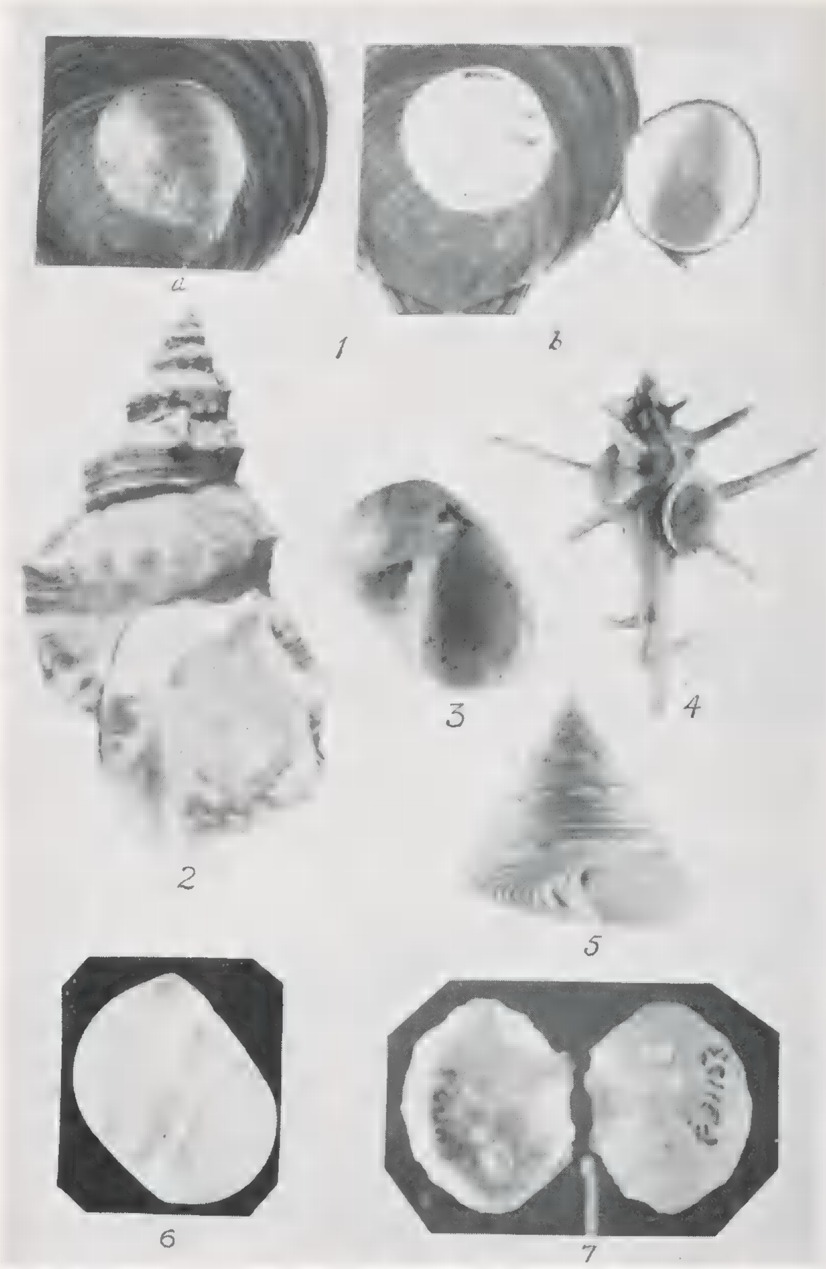

PLATE 2.

Fig. 1a, 1b: *Cavulus sycophanta* Garrard. Holotype. Aust. Mus. C. 63342. Mag. X½.

Fig. 2: *Bursa latitudo* Garrard. Holotype. Nat. Mus. Vic. F. 21111. Mag. X2/3.

(Pl. 2, fig. 7.)

A small specimen from deep water N.N.E. of Cape Byron, 24 mm. long, 21 mm. from umbo to farthest point of ventral margin, 5 mm. in section, is more than usually light and frail for this species, but owing to the inherent risk in naming a new species of such variable shells as the genus *Ostrea*, the specimen obtained is catalogued herein until further material can be obtained. It varies in many ways from *nomades* Iredale, notably by total absence of any greenish colouring or green muscle scar, presence of fine reddish lines on the fairly flat upper valve, and considerably lighter construction generally. This appears to be the "small white oyster" to which Iredale refers in the two final paragraphs of his description of *nomades*, but the illustration shown at Pl. 7, f. 1a, is a typical *nomades* and not this flatter and frailer form.

Description: Shell small, adherent, frail, translucent, inequilateral; upper valve slightly convex with crenulated margins, lower valve flat with vertically raised ventral margin; sculpture consists only of irregular concentric growth striae; hinge line long and narrow; muscle scar very small; colouration off-white with extremely fine broken irregular lines of reddish orange radiating from umbo to ventral margin on upper valve only.

Specimen described is in possession of the National Museum of Victoria, Melbourne, where it is registered No. F. 21153.

FAMILY MYTILIDAE

MODIOLUS Lamarck 1799, Mem. Soc. Nat. Hist. Paris, p. 87, type species by monotypy *modiolus* Linne.

peronianus Laseron 1956, Aust. Zool., 12, p. 269, f. 22-24.

One live specimen east of Bermagui.

SUBCLASS ANOMALODESMACEA

FAMILY THRACIIDAE

THRACIDENTULA gen. nov.

This new genus is created for a shell having, apart from the main characteristics of the family, an internal calcified ligament or lithodesma.

Generic description is: Shell oblong, equilateral, ventricose, gaping posteriorly; anterior dorsal margin concave, posterior dorsal margin convex, tapering more anteriorly than posteriorly; right valve slightly overlapping left at posterior dorsal margin; whole shell covered with small elevated granules arranged radially; valves joined internally by a calcified ligament or lithodesma.

PLATE 2—Continued.

Fig. 3: *Propesinum umbilicatum minusculum* Iredale. Aust. Mus. C. 63354. Mag. X2.

Fig. 4: *Poirieria kurranulla* Garrard. Holotype. Nat. Mus. Vic. F. 21118. Mag. X1.

Fig. 5: *Astele bularra* Garrard. Holotype. Aust. Mus. C. 63341. Mag. X1.

Fig. 6: *Polinices putealis* Garrard. Holotype. Aust. Mus. C. 63344. Mag. X1.

Fig. 7: *Ostrea ? nomades* Iredale. Nat. Mus. Vic F. 21153 Mag. X1.

Thracidentula perulae sp. nov.

(Pl. 1, fig. 10.)

Description: Shell oblong, equilateral, inequivalve, thin, semi-transparent, posterior side truncated and widely gaping, anterior side rounded, a slight furrow runs obliquely from umbo to posterior ventral margin on both valves; lunule long and narrow; resilifer long and widening towards posterior end, attached for full length; interior connecting lithodesma shaped like an arrow head when viewed from above, in situ pointing to anterior end.

Sculpture consists of wavy radiating irregularly spaced lines of fine granules, covered by a fine pale salmon-pink periostracum. Colour of shell off-white, lunule bright salmon-pink; interior of shell nacreous and off-white; pallial sinus wide and shallow.

Dimensions: Holotype, length 36 mm., height 26 mm., section of conjoined valves 15 mm.

Type Locality: In 45 fathoms east of Broken Bay, N.S.W.

Types: Holotype presented to Australian Museum, Sydney, where it is registered No. C. 63340, with one paratype; one paratype in author's collection, with another from 50 fathoms east of Newcastle, and a further paratype from type locality presented to National Museum of Victoria, Melbourne.

FAMILY POROMYIDAE

ECTORISMA Tate 1892, Trans. Roy. Soc. South Aust., 15, p. 127, type species by original designation *granulata* Tate.

granulata Tate 1892, Trans. Roy. Soc. South Aust., 15, p 127, pl. 1, figs. 3, 3a.

One live specimen in 100 fathoms east of Stanwell Park.

FAMILY CUSPIDARIIDAE

CUSPIDARIA Nardo 1840, Revue Zool. Soc. Cuv. 1840, p. 30, type species by original designation *cuspidata* Olivi.

latesulcata Tenison-Woods 1878, Proc. Linn. Soc. N.S.W., 2, p. 123.

One live specimen off Cape Moreton; three live specimens in 45 fathoms east of Broken Bay; one live specimen in 37-40 fathoms east of Barrenjoey Light; two single valves in 45 fathoms east of Botany Bay.

exarata Verco 1908, Trans. Roy. Soc. South Aust., 32, p. 199, pl. 12, figs. 6, 7.

One dead specimen in 142 fathoms east of Tuggerah Lakes; one dead specimen in 45 fathoms off Broken Bay; five live specimens in 70 fathoms east of Stanwell Park.

SUBCLASS TELEODESMACEA

FAMILY EUCRASSATELLIDAE

EUCRASSATELLA Iredale 1924, Proc. Linn. Soc. N.S.W., 49, pp. 181, 202, type species by original designation *kingicola* Lamarck.

kingicola Lamarck 1805, Ann. Mus. Hist. Nat. Paris, 6, p. 408.

One live specimen in 40 fathoms east of Twofold Bay.

FAMILY CARDITIDAE

CARDITA Bruguiere 1792, Tabl. Ency. Meth. Vers., 2, p. 401, type species by subsequent designation (Fleming 1818, Conchology (Encycl. Britt., Suppl. 3) p. 305) *variegata* Bruguiere.

amabilis Deshayes 1854, Proc. Zool. Soc. Lond., 1852, p. 102, pl. 17, figs. 8, 9.

One single valve in 65 fathoms east of Broken Bay; one single valve in 50 fathoms east of Botany Bay.

VIMENTUM Iredale 1925, Rec. Aust. Mus., 14, pp. 248, 254, type species by original designation *dilectum* Smith.

cavaticum Hedley 1902, Mem. Aust. Mus., 4, p. 318, fig. 58.

One single valve in 50 fathoms east of Broken Bay; two live specimens and four single valves in 50 fathoms east of Botany Bay.

BATHYCARDITA Iredale 1924, Proc. Linn. Soc. N.S.W., 49, pp. 182, 205, type species by original designation *raouli* Angas.

raouli Angas 1872, Proc. Zool. Soc. Lond., 1872, p. 613, pl. 42, f. 12.

A fair number of live specimens obtained along most parts of the New South Wales coast from Port Stephens to the Victorian border, in depths from 50 to 90 fathoms.

FAMILY DOSINIIDAE

MERIDOSINIA Iredale 1930, Rec. Aust. Mus., 17, p. 394, type species by original designation *nedigna* Iredale.

nedigna Iredale 1930, Rec. Aust. Mus., 17, p. 394, pl. 64, figs. 4, 5.

One single valve in 45 fathoms east of Botany Bay.

FAMILY LIOCONCHIDAE

NOTOCALLISTA Iredale 1924, Proc. Linn. Soc. N.S.W., 49, pp. 182, 210, type species by original designation *kingii* Gray.

kingii Gray 1826, Survey Coasts Austral. (King), 2, p. 476.

One live specimen in 76-80 fathoms east of Lake Macquarie; one live specimen in 37-40 fathoms east of Barrenjoey Light; six live specimens in 65 fathoms east of Stanwell Park; one live specimen in 45 fathoms east of Port Kembla.

FAMILY SOLECURTIDAE

SOLECURTUS Blainville 1824, Dict. Sci. Nat. (Levr.), 32, p. 351, type species by subsequent designation (Deshayes 1829, Dict. Class. d'Hist. Nat., 15, p. 482) *strigilatus* Linne.

australis Deshayes 1862, Proc. Zool. Soc. Lond., 1861, p. 424.

One live specimen in 75-85 fathoms N.E. of Newcastle.

FAMILY MACTRIDAE

NANNOMACTRA Iredale 1930, Rec. Aust. Mus., 17, p. 400, type species by original designation *jacksonensis* Smith.

pusilla A. Adams 1855, Proc. Zool. Soc. Lond., p. 226.

One live juvenile specimen in 50 fathoms east of Port Kembla.

CLASS GASTROPODA

SUBCLASS PROSOBRANCHIA

FAMILY TROCHIDAE

ARCHIMINOLIA Iredale 1929, Rec. Aust. Mus., 17, p. 170, type species by original designation *oleacea* Hedley & Petterd.

oleacea Hedley & Petterd 1906, Rec. Aust. Mus., 6, p. 215, pl. 37, f. 1.

One large dead specimen in 140 fathoms off Norah Head. An extremely rare species.

CLANCULUS Montfort 1810, Conch. Syst., 2, p. 190, type species by original designation *pharaonius* Linne.

albugo Watson 1885, Chall. Zool., 15, p. 75, pl. 6, f. 8.

One dead specimen in 75 fathoms east of Botany Bay.

ASTELE Swainson 1854, Proc. Roy. Soc. Tas., 3, p. 36, types species by monotypy *subcarinatum* Swainson.

subcarinatum Swainson 1854, Proc. Roy. Soc. Tas., 3, p. 36, pl. 6, figs. 1, 2.

Two dead specimens in 30 fathoms east of Lakes Entrance; one dead specimen in 45 fathoms east of Bermagui.

*Astele bularra** *sp. nov.*

(Pl. 2, fig. 5.)

Remarks: This species is another very fine addition to the attractive shells comprising the subfamily Calliostomatinae, and the fact that this shell has also come to hand since from fairly shallow water in Moreton Bay, also off Caloundra and Broken Bay, is further indication of the number of new species which probably still await discovery on the eastern continental shelf, if and when an organised dredging expedition can be undertaken.

Description: Shell of medium size, regularly trochoid, umbilicus partially callused over; protoconch very small, smooth, medium brown in colour, of one whorl only, set at an oblique angle, and merging gradually into sculpture of main whorls, which number nine; sculpture cancellate in earlier whorls, the longitudinal striations becoming less pronounced until sculpture resolves itself into revolving rows of uniform beading, a double row being present on the somewhat prominent shoulders above the sutures, and four rows between each shoulder and the suture above; midway between these rows is a less prominent row of beading, with smaller ones on either side, the whole crossed by faint oblique growth lines; base slightly convex with nine prominent rows of beading and smaller rows interposed as on the upper side of whorls, and still smaller lines between these as before, the whole crossed by obliquely radiating growth striae; colour of shell pale cream shading to light luminous bronze on later whorls, on which the more prominent rows of beading stand out as white lines; last row of beading above suture has brown spots at regular intervals; base white.

Columella curved outwards and approximately parallel with outside edge of shell, aperture thus being roughly the shape of a parallelogram;

*An aboriginal word meaning "several waters".

the small umbilicus half covered by a reflected nacreous callus formed over inner lip, whilst a well defined funicle ascends spirally from base of callus into umbilicus.

Dimensions: Holotype, height 28 mm., major diameter 27 mm., minor diameter 24 mm.

Type Locality: Trawled off Cape Moreton, Q., exact depth unknown.

Types: Holotype registered at Australian Museum, Sydney, No. C. 63341, with one paratype; two paratypes registered at National Museum of Victoria, Melbourne, No. F. 21139; one dead specimen in author's collection from 50 fathoms east of Broken Bay, with three dead specimens from 40 fathoms east of Caloundra, Q.

SALSIPOTENS Iredale 1924, Proc. Linn. Soc. N.S.W., 49, p. 230, type species by original designation *armillatus* Wood.

speciosa A. Adams 1855, Proc. Zool. Soc. Lond., p. 38.

Two live specimens in 50 fathoms east of Broken Bay.

FAMILY TURBINIDAE

BELLASTRAEA Iredale 1924, Proc. Linn. Soc. N.S.W., 49, p. 232, type species by original designation *kesteveni* Iredale.

kesteveni Iredale 1924, Proc. Linn. Soc. N.S.W., 49, p. 232.

Two live specimens in 45 fathoms east of Botany Bay.

FAMILY LIOTIIDAE

AUSTROLIOTIA Cotton 1948, Trans. Roy. Soc. South Aust., 7 (1), p. 30, type species by original designation *botanica* Hedley.

scalaris Hedley 1903, Mem. Aust. Mus., 4, p. 336.

Hedley's description and Iredale's illustration published in 1936, (Rec. Aust. Mus., 19 (5), p. 287, pl. 21, f. 15), are based on the only two specimens then recorded, both with immature lips. A single mature specimen now recorded from 75 fathoms east of Broken Bay agrees in all respects with the original description and illustration, the mature mouth being perfectly circular and entire, the margin broadened by a thick varix.

FAMILY RISSOINIDAE

STIVA Hedley 1904, Proc. Linn. Soc. N.S.W., 29, p. 192, type species by original designation *ferruginea* Hedley.

ferruginea Hedley 1904, Proc. Linn. Soc. N.S.W., 29, p. 192, pl. 9, f. 23-25.

Six dead specimens from 50 fathoms east of Botany Bay; one in 45 fathoms east of Broken Bay.

FAMILY CALYPTRAEIDAE

SIGAPATELLA Lesson 1830, Zool. Coquille, 2, p. 389, type species by subsequent designation (Dall 1909, U.S. Geol. Survey Prof. pap., 591, p. 82) *novaezelandiae* Lesson.

calyptraeformis Lamarck 1822, Hist. Anim. s. Vert., 7, p. 12.

One dead specimen in 37-40 fathoms east of Barrenjoey Light; one alive in 45 fathoms east of Botany Bay; one dead and two live

specimens in 45 fathoms east of Port Kembla attached to dead shells.

CAPULUS Montfort 1810, Conch. Syst., 2, p. 54, type species by original designation *hungaricus* Linne.

devotus Hedley 1904, Proc. Linn. Soc. N.S.W., 29, p. 190, pl. 8, f. 15-16.

Seven dead specimens in unknown depth south of Cape Moreton; four live specimens in 156-160 fathoms east of Newcastle; three live specimens in 100-126 fathoms 40 miles E.N.E. of Sydney; a number of live specimens taken in 70 fathoms and over, east of Broken Bay, mostly attached to inner lip of dead *Cymatona kampylum* Watson; two live specimens in 85 fathoms east of Stanwell Park.

Capulus sycophanta sp. nov.

(Pl. 2, figs. 1a, b.)

Remarks: In common with a number of shells in the past, this appears to be yet another instance of one which has been known to local fishermen and others for many years but apparently never forwarded to a Museum for identification. A study of the animal has not yet been carried out, but it is apparently parasitic in habit, as in addition to adhering to the shell of the common *Amusium balloti* Bernardi, in every adherent specimen received a hole has been bored into the host shell, varying in size from about ⅛" to 3/16". The shell invariably adheres with the beak pointing approximately in the direction of the umbonal area of the host, the hole drilled close to the left hand margin of its own shell. This new species is strongly reminiscent of *Capulus dilatatus* A. Adams, from Japan.

Description: Shell large for the family, sub-circular in outline, fairly well elevated; nucleus smooth and well recurved, sometimes straight but can be inclined to right or left, usually level with edge of shell or projecting a little beyond it; sculpture of numerous fine radiating striae, commencing at base of beak, and extending to margin in every direction, in some cases commencing on beak itself, and crossed by irregular growth lines.

Colouration light fawn background with light pinkish-brown radiating rays, usually a pink tinge on beak; interior quite smooth and polished, sometimes pure white with pink edge, often flushed with carmine; a light fawn periostracum present over whole outer surface.

Dimensions: Holotype, length 37 mm., breadth 33 mm., height 14 mm.

Type Locality: Trawled in 25 fathoms in Keppel Bay.

Types: Holotype presented to Australian Museum, Sydney, where it is registered No. C. 63342, with several paratypes; several paratypes in author's collection, others presented to National Museum of Victoria.

FAMILY CERITHIIDAE

ATAXOCERITHIUM Tate 1894, Jour. Roy. Soc. N.S.W., 32, p. 179, type species by original designation *serotinum* A. Adams 1855.

applenum Iredale 1936, Rec. Aust. Mus., 19 (5), p. 291, pl. 21, f. 19.

Two live specimens in 50 fathoms east of Lakes Entrance.

FAMILY TURRITELLIDAE

GAZAMEDA Iredale 1924, Proc. Linn. Soc. N.S.W., 49, p. 247, type species by original designation *gunnii* Reeve.

gunnii Reeve 1849, Conch. Icon., 5, pl. 9, f. 45.

Found in fair numbers in 40 to 100 fathoms from Broken Bay to Port Kembla; two in 35 fathoms S.E. of Lakes Entrance.

tasmanica Reeve 1849, Conch. Icon., 5, pl. 9, f. 42.

Two dead specimens east of Broken Bay; seven dead specimens in 40 to 70 fathoms east of Port Kembla; three dead specimens east of Bermagui; three dead specimens in 35 fathoms S.E. of Lakes Entrance.

decoramen Iredale 1936, Rec. Aust. Mus., 19, (5), p. 292, pl. 21, f. 20.

Three dead specimens east of Botany Bay.

PLATYCOLPUS Donald 1900, Proc. Mal. Soc. Lond., 4, p. 54, type species by original designation *quadratus* Donald.

quadratus Donald 1900, Proc. Mal. Soc. Lond., 4, p. 54, pl. 5, f. 8, 8b.

Five dead specimens in 40 fathoms east of Twofold Bay.

FAMILY ZEMIRIDAE

ZEMIRA H. & A. Adams 1853, Gen. Rec. Moll., p. 110, type species by monotypy *australis* Sowerby.

australis Sowerby 1841, Conch. Illustr., p. 20, List 8, f. 5.

One live specimen in 73-80 fathoms east of Lake Macquarie; one dead specimen in 75 fathoms east of Stanwell Park; one live specimen S.E. of Lakes Entrance.

FAMILY XENOPHORIDAE

XENOPHORA Fischer 1807, Mus. Demidoff., 3, p. 213, type species by monotypy *laevigata* G. Fischer (= *conchyliophora* Born).

peroniana Iredale 1929, Rec. Aust. Mus., 17 (4), p. 172.

Found in fair quantities from Port Stephens to Bass Strait in varying depths up to 100 fathoms, and one of the commonest shells trawled off the N.S.W. coast during the survey.

FAMILY STROMBIDAE

LAMBIS Röding 1798, Mus. Bolten, 2, p. 61, type species by tautonymy *lambis* Linne.

lambis Linne 1758, Syst. Nat., Ed. 10, p. 743.

One juvenile specimen east of Broken Bay, depth unknown.

FAMILY EPITONIIDAE (SCALIDAE)

DANNEVIGENA Iredale 1936, Rec. Aust. Mus., 19 (5), p. 303, type species by original designation *martyr* Iredale.

martyr Iredale 1936, Rec. Aust. Mus., 19 (5), p. 303, pl. 22, f. 25.

Three dead specimens in 70 fathoms east of Stanwell Park.

FAMILY CYMATIIDAE

CHARONIA Gistel & Bromme 1847, Handb. Naturg., p. 559, type species by monotypy *tritonis* Linne.

euclia instructa Iredale 1929, Rec. Aust. Mus., 17 (4), p. 172, pl. 41, f. 5.

Four immature live specimens in 50 fathoms east of Broken Bay.

CABESTANIMORPHA Iredale 1936, Rec. Aust. Mus., 19, p. 307, type species by original designation *exarata* Reeve (= *tabulata* Menke).

tabulata Menke 1843, Spec. Moll. Nov. Holl., p. 25.

Trawled in fair numbers and in varying depths from Newcastle to Port Kembla.

zimara Iredale 1929, Aust. Zool., 5 (4), p. 345, pl. 38, f. 11.

Two dead specimens east of Broken Bay; one dead specimen east of Bermagui.

MONOPLEX Perry 1811, Conch., pl. 3, type species by subsequent designation (Clench & Turner 1957, Johnsonia, 3, p. 227) *australasiae* Perry.

australasiae Perry 1811, Conch., pl. 4, f. 2, 4.

One dead specimen N.N.E. of Cape Byron.

CYMATONA Iredale 1929, Rec. Aust. Mus., 17, p. 177, type species by original designation *kampyla* Watson.

kampyla Watson 1885, Jour. Linn. Soc. Zool., 16, p. 594.

Found in fair numbers, all dead specimens, in depths of 70 fathoms and over from Newcastle to Stanwell Park, a number having *Capulus devotus* Hedley attached, always to inner lip.

PHANOZESTA Iredale 1936, Rec. Aust. Mus., 19 (5), p. 309, type species by original designation *remensa* Iredale.

remensa Iredale 1936, Rec. Aust. Mus., 19 (5), p. 309, pl. 23, f. 4.

Found in fair numbers in 70 fathoms and over off Broken Bay and Botany Bay, those from former locality all being taken alive, those from latter locality all dead specimens.

FUSITRITON Cossman 1903, Essai Paleo. comp., 5, p. 87, type species by original designation *cancellatus* Lamarck.

retiolus Hedley 1914, Biol. Res. Endeav., 2, p. 73, pl. 11, f. 5.

Two dead specimens in 75 fathoms east of Broken Bay; one in 120-125 fathoms east of Manly.

AUSTROSASSIA Finlay 1931, Trans. New Zeal. Inst., 62, p. 7, type species by original designation *parkinsonia* Perry.

parkinsonia basilica Iredale 1924, Proc. Linn. Soc. N.S.W., 49 (3), p. 253, pl. 35, f. 4.

Four dead specimens east of Botany Bay; one east of Port Kembla.

MAYENA Iredale 1917, Proc. Malac. Soc., 12, p. 324, type species by original designation *australasia* Perry.

australasia Perry 1811, Conch., pl. 4, figs. 2, 4.

One dead specimen east of Bermagui.

australasia benthicola Iredale 1929, Rec. Aust. Mus., 17 (4), p. 174, pl. 41, f. 4.

Trawled in fair numbers east of Broken Bay, Botany Bay and Port Kembla.

DISTORSIO Röding 1798, Mus. Bolten, 2, p. 133, type species by subsequent designation (Pilsbry 1922, Proc. Acad. Nat. Sci. Philad., 73, p. 357) *anus* Linne.

francesae Iredale 1931, Rec. Aust. Mus., 18 (4), p. 213, pl. 23, f. 2.

One dead specimen off Cape Moreton; one dead specimen east of Broken Bay; one dead specimen east of Port Kembla.

BURSA Röding 1798, Mus. Bolten, 2, p. 128, type species by subsequent designation (Jousseaume 1881, Bull. Soc. Zool. France, 6, p. 175) *bufonia* Gmelin.

Bursa latitudo sp. nov.

(Pl. 2, fig. 2.)

Remarks: In common with many other shells from fairly deep water, this species is thinner and lighter in weight than others of the family of comparable size, and the possibility that it only inhabits the waters beyond the edge of the continental shelf could account for its not being previously discovered by trawling.

Description: Shell of fair size, light in weight, less nodular than most of the genus; protoconch of 3½ whorls, first of which is planate, smooth, and terminates abruptly before commencement of main whorls, which number six; varices ten, sculpture consisting of very fine numerous revolving striae, with a row of fairly prominent nodules in centre of each whorl, a second row visible in places at the base of each whorl, at times covered by sutures, whilst a third rather obsolete row shows towards anterior end of body whorl; aperture sub-circular, outer lip thickened and dentate within, a fairly heavy callus formed over inner lip and finely wrinkled; canal short, open and recurved; a well defined posterior sinus present with a fairly prominent ridge adjoining on inner lip; colour light fawn with small patches of brown on nodules and varices; whole of aperture and interior pure white.

Dimensions: Holotype, length 95 mm., breadth 55 mm., length of aperture, excluding posterior sinus, 26 mm.

Type Locality: Trawled in 125 fathoms off Moreton Is., Q.

Type: Holotype registered at National Museum of Victoria, Melbourne, No. F. 21111; one small and badly damaged paratype registered at the Australian Museum, No. C. 63353.

FAMILY CASSIDIDAE

XENOGALEA Iredale 1927, Rec. Aust. Mus., 15 (5), p. 339, type species by original designation *pyrum* Lamarck.

insperata Iredale 1927, Rec. Aust. Mus., 15 (5), p. 349, pl. 31, f. 8.

One dead specimen in 50 fathoms off Broken Bay; one dead specimen in 45 fathoms off Stanwell Park.

thomsoni Brazier 1875, Proc. Linn. Soc. N.S.W., 1, p. 8.

One live specimen in 110-115 fathoms N.E. of Newcastle; one live specimen in 95 fathoms east of Tuggerah; four live specimens in 60 fathoms east of Broken Bay; five live specimens in 60 fathoms east of Botany Bay; two live specimens in 50 fathoms east of Stanwell Park.

pyrum Lamarck 1822, Hist. Anim. s. Vert., 7, p. 226.

Two live specimens in 60 fathoms east of Broken Bay; one live specimen in 60 fathoms east of Botany Bay.

NANNOCASSIS Iredale 1927, Rec. Aust. Mus., 15 (5), p. 328, type species by original designation *nana* Tenison-Woods.

nana Tenison-Woods 1879, Proc. Linn. Soc. N.S.W., 4, p. 108.

Three dead specimens off Cape Moreton, three south of Cape Moreton, one off Moreton Is., depths unknown.

SEMICASSIS Morch 1852, Cat. Conch. Yoldi., 1, p. 112, type species by subsequent designation (Harris 1897, Cat. Tert. Moll. Brit. Mus., 1, p. 198) *japonica* Reeve.

diuturna Iredale 1927, Rec. Aust. Mus., 15 (5), p. 335, pl. 32, f. 9

Two dead specimens off Cape Moreton, unknown depth.

Pulchroniscia delecta gen. et sp. nov.

(Pl. 1, figs. 9a, b.)

Remarks: A very fine new species was trawled in 75 fathoms east of Botany Bay, which although not an actual Cassid form is placed in this family for the present as being the closest available. Related to *Oniscidia cancellata* Sowerby from China, which was recently trawled in Queensland.

Generic characteristics are the pyriform shape, acuminate spire, heavy reflected and denticulate outer lip, and strong axial plications.

Description: Shell pyriform in shape, spire fairly acuminate, main whorls five; protoconch of three whorls, exserted, smooth and translucent; aperture produced posteriorly, at maturity level with shoulder of preceding whorl and 72% of total length of shell; outer lip thickened and recurved, finely denticulate within; a heavy callus over inner lip extending onto main body whorl, finely denticulate at posterior end, merging into an irregular row of small nodules at anterior end; sculpture of strong axial plications, slightly spinose on shoulders and weakening towards anterior end, there being sixteen on main body whorl; fairly fine growth striae in interstices and over-riding the plications, the whole crossed by

fairly strong concentric ridges; colour a blending of pale cream to fawn, giving a slightly banded appearance, four light brown patches on recurved edge of outer lip, and a narrow brown blotch in centre of columella.

Dimensions: Holotype, length 40 mm., breadth 26 mm., length of aperture 29 mm.

Type Locality: Dredged in 75 fathoms east of Botany Bay, N.S.W.

Type: The holotype, the only known specimen, presented to Australian Museum, Sydney, where it is registered No. C. 63343.

FAMILY TONNIDAE

TONNA Brunnich 1772, Zool. Fund., p. 248, type species by monotypy *galea* Linne.

tetracotula Hedley 1919, Rec. Aust. Mus., 12, p. 332, pl. 42-43, f. 4-5.

Two dead specimens off Cape Moreton, depth unknown.

EUDOLIUM Dall 1889, Bull. Mus. Comp. Zool. (Harvard), 18, pp. 20, 232, type species by original designation *crosseanum* Monterosato.

pyriforme Sowerby 1914, Ann. Mag. Nat. Hist., (8), 14, p. 37, pl. 2, f. 14.

One dead specimen in 75 fathoms east of Broken Bay.

FAMILY FICIDAE

FICUS Röding 1798, Mus. Bolten, 2, p. 148, type species by tautonymy *ficus* Gmelin.

filosus Sowerby 1893, Conchologist, 2, p. 74.

Two live specimens in 75 fathoms east of Broken Bay.

Remarks: Although the type locality for this species is given as Hong Kong, and to the author's knowledge it has not been recorded previously from the Australian coast, the two specimens now recorded agree well with the original description. Moreover the general outline and sculpture appear to be identical with the excellent photographs by Kuroda and Habe in Illustrated Catalogue of Japanese Shells, No. 19, 1952, p. 134. There appears no reason therefore to re-name the shells now recorded merely because of the distance from the type locality.

This is not the common species usually called *communis* Röding from the east coast of Australia, which in any case is probably *Ficus ficoides* Lamarck, and of which *Ficus margaretae* Iredale (Rec. Aust. Mus., 18 (4), 1931, p. 216, pl. 23, f. 4) must be regarded as a synonym.

FAMILY NATICIDAE

NOTOCOCHLIS Powell 1933, Trans. New Zeal. Inst., 63, p. 166, type species by original designation *migratoria* Powell.

luculenta Iredale 1929, Rec. Aust. Mus., 17, p. 179, pl. 40, f. 10.

Two dead specimens in 70 fathoms east of Broken Bay; three dead specimens from 70 fathoms east of Stanwell Park; one dead specimen in 50 fathoms east of Port Kembla.

POLINICES Montfort 1810, Conch. Syst., 2, p. 222, type species by original designation *albus* Montfort = *mamilla* Linne.

Polinices putealis sp. nov.

(Pl. 2, fig. 6.)

Remarks: It appears remarkable that the shell here described should have remained undiscovered for so long, being in a locality which has been trawled for so many years, and ten specimens were received from the "Challenge" on one trip to the area. It cannot be confused with any other species, being pure white and shining, with the umbilicus extending right through to the spire of shell.

Description: Shell solid, helicoid, very glossy; pure white, carrying traces of a light fawn and very thin periostracum; whorls five, slowly increasing, the last half whorl descending and expanding rapidly; spire small and acute; aperture oblique, semi-lunate and nearly half total breadth; callus narrow with very small lobe extending slightly across the wide umbilical opening, which narrows gradually as it extends through to spire of shell.

Dimensions: Holotype, length 27 mm., breadth 22 mm., length of aperture 17 mm.

Type Locality: Trawled in 50-58 fathoms east of Botany Bay.

Types: Holotype presented to Australian Museum, Sydney, where it is registered No. C. 63344 with two paratypes; three paratypes presented to National Museum of Victoria, Melbourne, and four paratypes in author's collection.

FRIGINATICA Hedley 1915, Aust., Antarc. Exped., 1911-14, Sci. Rep., 4, p. 57, type species by original designation *beddomei* Johnston.

beddomei Johnston 1885, Proc. Roy. Soc. Tas., 1884, p. 222 (= *effossa* Watson 1886, Rep. Sci. Res. Challenger Zool., 15, p. 439, pl. 28, f. 3).

One dead specimen in 45 fathoms east of Botany Bay.

PROPESINUM Iredale 1924, Proc. Linn. Soc. N.S.W., 49, p. 256, type species by monotypy *umbilicatum* Quoy & Gaimard.

umbilicatum minusculum Iredale 1924, Proc. Linn. Soc. N.S.W., 49, p. 256.

(Pl. 2, fig. 3.) Not previously figured.

One live specimen in 45 fathoms east of Botany Bay, Australian Museum, No. C. 63354.

FAMILY LAMELLARIIDAE

MYSTICONCHA Allan 1936, Rec. Aust. Mus., 19, p. 393, type species by original designation *wilsoni* Smith.

wilsoni Smith 1886, Ann. Mag. Nat. Hist., (5) 18, p. 270 and figure.

One live specimen in 35 fathoms S.E. of Newcastle.

FAMILY TRIVIIDAE

ELLATRIVIA Iredale 1931, Rec. Aust. Mus., 18, p. 221, type species by original designation *merces* Iredale.

merces addenda Iredale 1931, Rec. Aust. Mus., 18, p. 221. Not figured.

One live specimen in 37-40 fathoms east of Barrenjoey Light; two live specimens in 50 fathoms S.E. of Lakes Entrance.

FAMILY UMBILIIDAE

UMBILIA Jousseaume 1884, Le Naturaliste, 6th year, p. 414, type species by monotypy *umbilicata* Sowerby (= *hesitata* Iredale).

hesitata Iredale 1916, Proc. Malac. Soc., 12, p. 93.

Found in large numbers alive in depths from 25 to 100 fathoms from vicinity of Port Stephens to Bass Strait. The belief that mature shells decrease in size as the northern limit of their range is reached (subspecies *beddomei* Schilder 1930) cannot be sustained, as fully mature shells ranging in length from 101 mm. down to 51 mm. were obtained throughout the full length of this range.

FAMILY CYPRAEIIDAE

SOLVADUSTA Iredale 1935, Aust. Zool., 8, p. 217, type species by original designation *vaticina* Iredale.

subviridis Reeve 1835, Proc. Zool. Soc. Lond., p. 68, and Conch. Icon., 3, 1845, *Cypraea*, pl. 12, f. 48.

One live specimen off Moreton Is.

VOLVA Röding 1798, Mus. Bolten, 2, p. 21, type species by tautonymy *volva* Linne.

volva Linne 1758, Syst. Nat. Ed., 10, p. 725.

One live specimen N.N.E. of Cape Byron.

FAMILY VOLUTIDAE

CYMBIOLISTA Iredale 1929, Rec. Aust. Mus., 17, p. 181, type species by original designation *hunteri* Iredale.

hunteri Iredale 1931, Rec. Aust. Mus., 18, p. 223.

One dead specimen off Cape Moreton; one dead specimen N.N.E. of Cape Byron.

CYMBIOLACCA Iredale 1929, Rec. Aust. Mus., 17, p. 181, type species by original designation *complexa* Iredale.

complexa Iredale 1924, Proc. Linn. Soc. N.S.W., 49, p. 258.

Two dead specimens N.N.E. of Cape Byron, N.S.W.

pulchra pulchra Sowerby 1825, Cat. Tankerville, App. p. 28, pl. 4, f. 2.

Three dead specimens east of Cape Moreton, Q., and four dead specimens south of same locality.

ERICUSA H. & A. Adams 1858, Gen. Rec. Moll., 2, p. 619, type species by subsequent designation (Cotton & Godfrey 1932, South Aust. Nat., 13, p. 49) *fulgetrum* Sowerby.

papillosa kenyoniana Brazier 1898, Proc. Linn. Soc. N.S.W., 22, p. 779.

One dead immature specimen in 90-100 fathoms east of Tuggerah Lakes.

sericata Thornley 1951, Proc. Roy. Zool. Soc. N.S.W., 1949-50, p. 53, figs. in text.

One large dead specimen in 50 fathoms east of Laurieton (in collection of Mr. Evans Paddon); one dead specimen off Cape Moreton; one off Moreton Is.

MESERICUSA Iredale 1929, Rec. Aust. Mus., 17, p. 181, type species by original designation *sowerbyi perspecta* Iredale.

sowerbyi perspecta Iredale 1929, Rec. Aust. Mus., 17, p. 181, pl. 41, f. 9.

One small dead specimen, deeply coloured, in 90-100 fathoms east of Tuggerah Lakes; two similar small dead specimens in 50 fathoms east of Broken Bay; one large dead specimen east of Bermagui.

NANNAMORIA Iredale 1929, Rec. Aust. Mus., 17, p. 181, type species by original designation *amicula* Iredale.

amicula Iredale 1929, Rec. Aust. Mus., 17, p. 181, pl. 40, f. 4.

Two dead specimens in 70 fathoms east of Broken Bay, and it is understood that a third specimen was obtained from the same area. Owing to the worn nature of the type specimen of this rare shell, opportunity is now taken to describe the colour as being a pale fawn background, with undulating longitudinal chestnut lines. A row of chestnut blotches encircles the body whorl, with chestnut splashes below the sutures.

parabola Garrard 1960, Jour. Mal. Soc. Aust., 4, p. 3, pl. 1, f. 1a, b.

One dead mature specimen and two immature specimens from 125 fathoms off Moreton Is., Q.

AMORENA Iredale 1929, Rec. Aust. Mus., 17, p. 180, type species by original designation *undulata* Lamarck.

undulata Lamarck 1804, Ann. Mus. Hist. Nat. Paris, 5, p. 157, pl. 12, f. 1.

Found in fair quantities from Newcastle to Broken Bay area, mostly small and immature. It would seem from experience that the larger live specimens probably burrow too deeply to be brought up in the nets, especially during daylight hours; one dead specimen also from N.N.E. of Cape Byron.

RELEGAMORIA Iredale 1936, Rec. Aust. Mus., 19, p. 314, type species by original designation *molleri* Iredale.

molleri Iredale 1936, Rec. Aust. Mus., 19, p. 314, pl. 23, f. 10.

It is known that at least 30 live specimens were trawled between Newcastle and Broken Bay, in depths from 90 to 120 fathoms, mainly just over the edge of the continental shelf; one also N.N.E. of Cape Byron, N.S.W. Study of these shells reveals that the white glaze on the holotype as described by Iredale is not typical, all shells being a uniform light brown in colour and highly polished, whilst the peculiar ridge on the inside of the outer lip is present in all mature specimens and is not an aberration.

ZEBRAMORIA Iredale 1929, Rec. Aust. Mus., 17, p. 180, type species by original designation *zebra* Leach.

zebra Leach 1814, Zool. Miscell., 1, p. 31, pl. 12, f. 1.

Two live specimens off Cape Moreton.

TERNIVOLUTA Martens 1897, Arch. fur Naturg., 63, p. 177, type species by original designation *studeri* Martens.

studeri Martens 1897, Arch. fur Naturg., 63, p. 177-8, pl. 17, f.2.

At least 60 specimens are known to have been trawled in depths down to 125 fathoms off Moreton Is., many being alive.

FAMILY MICROVOLUTIDAE

MICROVOLUTA Angas 1877, Proc. Zool. Soc. Lond., 1877, p. 34, type species by monotypy *australis* Angas.

royana Iredale 1924, Proc. Linn. Soc. N.S.W., 49, p. 269, pl. 35, f. 13.

One dead specimen in 50 fathoms east of Botany Bay.

FAMILY MITRIDAE

VICIMITRA Iredale 1929, Aust. Zool., 5, p. 343, type species by monotypy *prosphora* Iredale.

prosphora Iredale 1929, Aust. Zool., 5, p. 343, pl. 38, f. 17.

One dead specimen off Cape Moreton; one dead specimen in 50 fathoms east of Broken Bay; two dead specimens in 45 fathoms east of Botany Bay.

AUSTROMITRA Finlay 1927, Trans. New Zeal. Inst., 57, p. 410, type species by original designation *rubiginosa* Hutton.

strangei Angas 1867, Proc. Zool. Soc. Lond., 1867, p. 110, pl. 13, f. 4.

One dead specimen east of Botany Bay.

FAMILY HARPIDAE

PALAMHARPA Iredale 1931, Rec. Aust. Mus., 18, p. 230, type species by original designation *exquisita* Iredale.

exquisita Iredale 1931, Rec. Aust. Mus., 18, p. 230, pl. 22, f. 8.

One dead specimen off Botany Bay; several fine dead specimens off Twofold Bay-Gabo Is. area; one live specimen in 33 fathoms off Deal Is., Bass Strait.

FAMILY OLIVIDAE

BELLOLIVA Peile 1922, Proc. Malac. Soc., 15, p. 18, type species by original designation *brazieri* Angas.

leucozona brazieri Angas 1877, Proc. Zool. Soc. Lond., 1877, p. 172, pl. 26, f. 6.

Two live specimens in 45 fathoms east of Botany Bay.

CUPIDOLIVA Iredale 1924, Proc. Linn. Soc. N.S.W., 49, p. 259, type species by original designation *nympha* A. Adams & Angas.

nympha A. Adams & Angas 1864, Proc. Zool. Soc. Lond., 1863, p. 422.

Three dead specimens off Botany Bay.

FAMILY ANCILLIDAE

ANCILLISTA Iredale 1936, Rec. Aust. Mus., 19, p. 314, type species by original designation *velesiana* Iredale.

velesiana Iredale 1936, Rec. Aust. Mus., 19, p. 314, pl. 23, f. 9.

One live specimen off Cape Moreton; one live specimen in 76-80 fathoms off Lake Macquarie.

ALOCOSPIRA Cossman 1899, Essais Paleo. comp. livr., 3, p. 92, type species by original designation *papillata* Tate.

oblonga Sowerby 1830, Spec. Conch., *Ancillaria*, p. 7, pl. 13, f. 38-9.

Five dead specimens off Port Kembla.

marginata tasmanica Tenison-Woods 1878, Proc. Roy. Soc. Tas., 1877, p. 30.

Two dead specimens in 45 fathoms east of Twofold Bay.

fusiformis gaza Iredale 1924, Proc. Linn. Soc. N.S.W., 49, p. 261, pl. 36, f. 9.

Two dead specimens in 50 fathoms east of Port Kembla; one dead specimen east of Bermagui.

FAMILY MARGINELLIDAE

OVAGINELLA Laseron 1957, Aust. Jour. Mar. Freshwater Res., p. 280, type species by original designation *ovulum* Sowerby.

ovulum Sowerby 1846, Thes. Conch., 1, p. 401, pl. 78, f. 188.

Three dead specimens off Botany Bay.

whani Pritchard & Gatliff 1900, Proc. Roy. Soc. Vic., 13, (n.s.), p. 137, pl. 21, f. 5-6.

One dead specimen off Botany Bay.

SINUGINELLA Laseron 1957, Aust. Jour. Mar. Freshwater Res., 8, p. 282, type species by original designation *inconspicua* Sowerby.

punicea Laseron 1948, Rec. Aust., Mus., 22, p. 38, pl. 5, f. 7.

Three dead specimens off Botany Bay.

binivitta Laseron 1948, Rec. Aust. Mus., 22, p. 39, pl. 5, f. 11.

Three dead specimens off Botany Bay.

KOGOMEA Habe 1951, Illus. Cat. Jap. Shells, (ed. T. Kuroda), p. 103, f. 11, type species by original designation *novem-provincialis* Yokoyama.

stilla Hedley 1903, Mem. Aust. Mus., 4, p. 367, f. 90.

Three dead specimens in 50 fathoms off Botany Bay.

PROTOGINELLA Laseron 1957, Aust. Jour. Mar. Freshwater Res., 8, p. 285, type species by original designation *lavigata* Brazier.

geminata Hedley 1912, Rec. Aust. Mus., 8, p. 145, pl. 42, f. 28.

One live specimen off Botany Bay.

FAMILY CANCELLARIIDAE

SYDAPHERA Iredale 1929, Aust. Zool., 5, p. 341, type species by original designation *renovata* Iredale.

anxifer Iredale 1925, Rec. Aust. Mus., 14, p. 264, pl. 43, f. 24.

One dead specimen in 45 fathoms east of Port Kembla.

FAMILY ARCHITECTONICIDAE

ARCHITECTONICA Röding 1798, Mus. Bolten, 2, p. 78, type species by subsequent designation (Gray 1847, Proc. Zool. Soc. Lond., p. 151) *perspectiva* Linne.

offlexa Iredale 1931, Rec. Aust. Mus., 18, p. 229, pl. 25, figs. 15-16.

One dead specimen in 90-100 fathoms east of Tuggerah Lakes; one live specimen in 72 fathoms off Point Newcastle; four live specimens off Broken Bay, depth unknown; three live specimens off Stanwell Park and three off Port Kembla, depths unknown.

grandiosa Iredale 1931, Rec. Aust. Mus., 18, p. 228, pl. 25, f. 19-20.

One dead specimen off Cape Moreton.

Russetia dilaniatus gen. et sp. nov.

(Pl. 1, figs. 11a, b.)

Remarks: The outstanding characteristic of this new genus is the rough and irregular nature of the peripheral keel in the later whorls, coupled with the peculiar base, convex in the centre and flattening towards the edges, otherwise the general appearance of the shell is fairly typical of the family.

Description: Shell depressed, of seven slightly concave whorls; planate protoconch; base convex, flattening towards periphery and umbilicus; umbilicus large and perspective, one-third total width of shell; edges finely beaded in earlier whorls, becoming rough and irregular as main whorl is reached; peripheral keel simple, becoming rough and irregular as maturity is reached, overlapping the suture in a more pronounced fashion with each succeeding whorl; sculpture of about nine fine spiral lirae below suture, followed by six further lirae of irregular widths towards peripheral keel, the whole over-ridden by fine growth lines; sculpture of base consists of three fairly prominent beaded ridges adjoining umbilicus, followed by two flattened ridges and numerous finer ridges towards periphery, the

whole crossed by fairly pronounced growth striae; columella sinuate and aperture narrows towards keel; colour very light fawn, base white.

Dimensions: Holotype, major diameter 43 mm., minor diameter 37 mm., height 16 mm.

Type Locality: Trawled in 160 fathoms east of Newcastle.

Type: Holotype, the only known specimen, presented to Australian Museum, Sydney, where it is registered No. C. 63345.

FAMILY FASCIOLARIIDAE

PLEIA Finlay 1930, Trans. New Zeal. Inst., 61, p. 60, type species by original designation *decipiens* Tate.

bakeri Gatliff & Gabriel 1912, Vict. Nat., 29, No. 3, p. 47, pl. 4, f. 5.

A fair number of live specimens in depths from 35 to 60 fathoms from Broken Bay to Twofold Bay.

FAMILY FUSINIDAE

FUSINUS Rafinesque 1815, Analyse Natur., p. 145, new name for *Fusus* Lamarck 1799, (not *Fusus* Helbling 1779), type species by monotypy *colus* Linne.

novaehollandiae Reeve 1848, Conch. Icon., 4, *Fusus,* pl. 18, f. 70.

Three fine specimens from 45 fathoms off Port Kembla, all very nodular and heavy; one dead specimen off Twofold Bay.

novaehollandiae grandiculus Iredale 1924, Proc. Linn. Soc. N.S.W., 49, p. 267, pl. 34, f. 9.

Many specimens obtained along most of N.S.W. coast from Norah Head southwards in various depths up to 160 fathoms and in various stages of growth.

PROPEFUSUS Iredale 1924, Proc. Linn. Soc. N.S.W., 49, p. 268, type species by monotypy *pyrulatus* Reeve.

pyrulatus Reeve 1847, Conch. Icon., 4, *Fusus,* pl. 3, figs. 50, 50a.

One immature specimen in 60 fathoms east of Port Kembla; one dead specimen off Broken Bay.

FAMILY AUSTROSIPHONIDAE

LARGISIPHO Iredale 1929, Rec. Aust. Mus., 17, p. 182, type species by original designation *spectandus* Iredale.

maximus Tryon 1881, Man. Conch., 3, p. 135, pl. 54, f. 355.

Fairly numerous in depths from 30 to 125 fathoms from Port Stephens to Bass Strait.

BERYLSMA Iredale 1924, Proc. Linn. Soc. N.S.W., 49, p. 267, type species by original designation *waitei* Hedley.

waitei Hedley 1903, Mem. Aust. Mus., 4, p. 373, pl. 37.

Seven live specimens in 75 fathoms off Broken Bay-Newcastle area.

FAMILY COLUBRARIIDAE

COLUBRARIA Schumacher 1817, Essai nouv. syst. Vers. test. p. 251, type species by monotypy *granulata* Schumacher.

Colubraria fantomei sp. nov.

(Pl. 1, fig. 5.)

Remarks: A most interesting addition to this somewhat difficult group was trawled in 40 fathoms east of Caloundra and is typical of the genus, bearing a strong resemblance to *Colubraria comptus* Sowerby but with finer sculpture. Three specimens were recently obtained, and whilst from another source not connected with "Challenge" material, it is considered that the species should be included with this list in view of the further species later described, trawled by m.v. "Challenge" off Broken Bay, N.S.W., in order to show the essential differences.

Description: Shell a typical *Colubraria,* spire longer than aperture, whorls convex, sutures impressed; one smooth whorl of protoconch only present, upper whorls missing, and this merges imperceptibly into sculpture of main whorls, which number eleven on holotype in addition to protoconch; varices number eighteen, spaced a little more than half a whorl apart, gradually increasing in distance until outer lip on last whorl is almost level with previous varix; aperture 40% of total length of shell, outer lip expanded and recurved, extended a little over previous whorl, finely dentate within, teeth being prolonged well into aperture; columella smooth and sinuate, inner lip much expanded and reflected; anterior canal open and well recurved; a rather obsolete ridge at top of columella suggests a posterior canal; sculpture of fairly fine revolving lirae, crossed by longitudinal striations which are slightly more prominent, giving a general granulated appearance; colouration pale fawn, with slightly darker fawn band in centre of each whorl, forming a dark patch on lower end of each varix; broken irregular revolving brown lines persist in addition over entire shell.

Dimensions: Holotype, length 75 mm., breadth 28 mm., length of aperture 30 mm. The two smaller specimens, both apparently mature, measure 58 mm. long and 22 mm. wide.

Type Locality: All specimens trawled in 40 fathoms east of Caloundra, Q.

Types: Holotype presented to Australian Museum, Sydney, where it is registered No. C. 63346, one paratype presented to National Museum of Victoria, Melbourne; further paratype in author's collection.

Colubraria myuna sp. nov.*

(Pl. 1, fig. 6.)

Remarks: Whilst it is always preferable to have a series of shells for study before describing a new species, and whilst the shell here described is fairly close in many ways to the species described above, it is considered that the differences are such as to warrant separation.

Description: Species essentially the same in general characteristics as *Colubraria fantomei* and may be described as a degenerate form, main

*An aboriginal word meaning "clear water".

difference being that shell is a considerably smaller species, sculpture less pronounced, tending to decrease more in prominence with each succeeding whorl, this being especially noticeable on varices; although whorls are also convex, sutures are not so impressed, teeth are not produced into interior of aperture, and anterior canal is less recurved; protoconch of three smooth tightly coiled whorls; small columella ridge is absent; colouration very similar to *fantomei* but markings paler and less pronounced.

Dimensions. Holotype, length 41 mm., breadth 15½ mm., length of aperture 17 mm.

Type Locality: Trawled in 75 fathoms east of Broken Bay, N.S.W.

Type: Holotype, the only known specimen, presented to Australian Museum, Sydney, where it is registered No. C. 63347.

BENTHINDSIA Iredale 1936, Rec. Aust. Mus., 19, p. 317, type species by original designation *problematica* Iredale.

problematica Iredale 1936, Rec. Aust. Mus., 19, p. 318, pl. 23, f. 7.

Found in fair numbers from 70 fathoms and over off Broken Bay, all dead specimens; one dead specimen off Botany Bay; four dead specimens off Stanwell Park, depths unknown.

FAMILY MURICIDAE

PTEROCHELUS Jousseaume 1879, Le Naturaliste, 1, No. 42, p. 335, type species by original designation *acanthopterus* Lamarck.

acanthopterus Lamarck, 1816, Encycl. Meth., vers., pl. 417, f. 2.

One live specimen off Moreton Is., depth unknown.

duffusi Iredale 1936, Rec. Aust. Mus., 19, p. 323, pl. 23, f. 11.

A number of fine specimens obtained, many alive, in fairly deep water from Newcastle to Twofold Bay.

damicornis Hedley 1903, Mem. Aust., Mus., 4, p. 378, f. 92.

Proved to be extremely common and brought up in quantities from Newcastle Bight to Twofold Bay, more particularly from Broken Bay to Port Kembla area, in varying depths from 35 to 126 fathoms; nine specimens also off Cape Moreton, in unknown depth.

HAUSTELLUM Schumacher 1817, Essai nouv. syst. Vers. test., pp. 64 & 213, type species by tautonymy *Murex haustellum* Linne.

espinosus Macpherson 1959, Mem. Nat. Mus. Melb., p. 51, pl. on p. 56, figs. 1, 1a.

Two dead specimens off Cape Moreton, depth unknown; two dead specimens in unknown depth N.N.E. of Cape Byron.

TORVAMUREX Iredale 1936, Rec. Aust. Mus., 19, p. 323, type species by original designation *denudatus* Perry.

denudatus Perry 1811, Conchology, pl. 7, f. 2.

One live specimen in 33 fathoms off Deal Is., Bass Strait; three dead specimens from 45 fathoms east of Broken Bay. Contrary to Iredale's remark in his description of *denudatus immunitus* Iredale (Rec. Aust. Mus., 19, 1936, p. 324, pl. 23, f. 14), that this sub-species from deep water shows "the single inter-variceal nodule of the shore shells", these three specimens all show the double inter-variceal nodules of the true *denudatus* Perry. On the other hand there is in the author's collection a specimen with single nodules only from 40 fathoms off Wollongong, but more fronded than most shore dwelling forms, whilst other specimens from Balmoral, Port Jackson, show in some cases very little frilling and have single and double nodules alternately, so that *immunitus* Iredale must be regarded as a synonym.

EUPHYLLON Jousseaume 1880, Le Naturaliste, 1, No. 42, p. 335, type species by original designation *monodon* Sowerby.

cervicornis Lamarck 1822, Hist. Anim. s. Vert., p. 163.

One live specimen off Cape Moreton.

POIRIERIA Jousseaume 1880, Le Naturaliste, 1, No. 42, p. 335, type species by original designation *zelandicus* Quoy & Gaimard.

*Poirieria kurranulla** *sp. nov.*

(Pl. 2, fig. 4.)

Remarks: This species, so far as known, has only been found in a fairly confined area. The author has a number trawled in 40 fathoms east of Caloundra, Q., and the within described specimen, the only one received from m.v. "Challenge", was marked as "off Cape Moreton", which is within a few miles of the same locality. Appears to be a fairly close relative of *Poirieria zelandicus* Quoy & Gaimard, from New Zealand waters.

Description: Shell of medium size, spire acuminate, sutures impressed; two whorled bulbous protoconch with somewhat oblique nucleus, terminating in a small varix; main whorls five; canal long, curved, and nearly closed; aperture oval, columella sinuate with callused and reflected inner lip, outer lip smooth with small anal groove; sculpture of irregular spiral lirae both above and below the fairly well defined shoulder on each whorl, crossed by irregular growth lines, persisting along full length of canal; two rows of long fairly straight spines produced from each varix and encircle body whorl, upper row being longer, and continuing in centre of smaller whorls, a rather obsolescent nodular formation occurs between the spines; three short curved spines occur on anterior canal; colour uniform pale fawn, inner and outer lip white, interior of aperture light pinkish purple; shell covered in young stages with furry greyish-fawn periostracum, which tends to disappear in mature shell; operculum oval, reddish-brown, with well defined overlapping growth lines and terminal nucleus.

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*An aboriginal word meaning "a small pink sea shell".

Dimensions: Holotype, length 42 mm., breadth 13 mm., length of aperture 8 mm., canal 20 mm., longest spine 18 mm.

Type Locality: Trawled off Cape Moreton, Q., exact depth unknown.

Type: Holotype registered at National Museum of Victoria, Melbourne, No. F. 21118; several paratypes from 40 fathoms east of Caloundra presented to Australian Museum, Sydney, and National Museum of Victoria, Melbourne.

FAMILY TROPHONIDAE

EMOZAMIA Iredale 1929, Rec. Aust. Mus., 17, p. 185, type species by original designation *licina* Hedley & Petterd.

licina Hedley & Petterd 1906, Rec. Aust. Mus., 6, p. 219, pl. 37, f. 6.

Several large live specimens from 35-50 fathoms off Botany Bay, Port Kembla, Bermagui and Twofold Bay.

XENOTROPHON Iredale 1929, Rec. Aust. Mus., 17, p. 184, type species by original designation *euschema* Iredale.

euschema Iredale 1929, Rec. Aust. Mus., 17, p. 184, pl. 40, f. 3.

One dead specimen in 60 fathoms east of Broken Bay; one dead specimen in 50 fathoms east of Botany Bay; two dead specimens in 60 fathoms east of Port Kembla.

FAMILY CORALLIOPHILIDAE

TOLEMA Iredale 1929, Rec. Aust. Mus., 17, p. 186, type species by original designation "*sertata* Hedley" = *australis* Laseron 1955.

australis Laseron 1955, Proc. Roy. Zool. Soc. N.S.W., 1953-54, p. 72, figs. 1-2.

A fair number of well grown live specimens in 50 to 70 fathoms in many places along the coast from Newcastle to Twofold Bay; immature live specimens fairly numerous off Port Kembla.

FAMILY COMINELLIDAE

BEDEVA Iredale 1936, Rec. Aust. Mus., 19, p. 273, type species by original designation *hanleyi* Angas.

hanleyi Angas 1867, Proc. Zool. Soc. Lond., p. 110, pl. 13, f. 1.

Two dead specimens off Botany Bay; one dead specimen off Port Kembla.

FAMILY COLUMBARIIDAE

COLUMBARIUM Martens 1881, Conch. Mittheil., 2, p. 105, type species by monotypy *spinicinctum* Martens.

hedleyi Iredale 1936, Rec. Aust. Mus., 19, pp. 315-6, pl. 24, f. 18, 18a.

(= *trabeatum* Iredale 1936.)

Shells obtained in fair numbers from Newcastle-Broken Bay area in depths from 90 to 160 fathoms. The number of ridges below the periphery varies from one to five, and the peripheral flange shows teeth both increasing and decreasing in size. The shell is

variable and *trabeatum* Iredale (Rec. Aust. Mus. 19 (5), 1936, p. 316, pl. 23, f. 17) must now be regarded as a synonym. The operculum of this species, not formerly described, is corneous, pear shaped, chestnut brown in colour, vertically grooved, with a terminal nucleus.

FAMILY TEREBRIDAE

ACUMINIA Dall 1908, Nautilus, 21, pp. 124-5, type species by original designation *lanceata* Lamarck.

lauretanae Tenison-Woods 1878, Proc. Linn. Soc. N.S.W., 2, p. 262.

One dead immature specimen in 70 fathoms east of Port Kembla.

TRIPLOSTEPHANUS Dall 1908, Nautilus, 21, pp. 124-5, type species by original designation *triseriatus* Gray.

praelongus Deshayes 1859, Proc. Zool. Soc. Lond., p. 135.

One dead specimen in 110-142 fathoms east of Newcastle; one dead specimen in 156-160 fathoms east of Newcastle; one dead specimen in 100-126 fathoms, 40 miles E.N.E. of Sydney.

FAMILY CONIDAE

FLORACONUS Iredale 1930, Mem. Q. Mus., 10, (1), p. 80, type species by original designation *anemone* Lamarck.

angasi Tryon 1884, Man. Conch., 6, p. 62, pl. 19, f. 99.

Two live specimens in 75 fathoms east of Stanwell Park.

*Floraconus wallangra** *sp. nov.*

(Pl. 1, fig. 3.)

Remarks: This species has presented some problems regarding its general shape and appearance, and more particularly as regards its very variable colour pattern. Also, a number of specimens received for study from as far north as Moreton Is., Q., are apparently all somewhat immature, but at the same time agree well in general shape and appearance with the one immature specimen received from m.v. "Challenge" from 75 fathoms east of Stanwell Park, together with two larger and mature shells.

Description: Shell medium size, light in weight, fairly straight sided, shoulders fairly sharply angled, aperture straight and linear, spire elevated and a little concave; protoconch two whorled and papillate, main whorls seven in number and concave; sculpture of rows of finely punctate lines at regular intervals on body whorl, tending to disappear with age, merging into oblique irregular ridges at anterior end; sculpture on spire of five or six fine but pronounced spiral lirae on each whorl, crossed by faint growth striae; colour medium brown on off-white ground, sometimes tinged with blue, in form of irregular blotches and maculations, tending to form two broad bands of brown round body whorl. In northern specimens these two bands tend to be more distinct than in southern specimens, whilst southern ones have revolving rows of irregular brown spots which tend

*An aboriginal word meaning "big water".

to become indistinct or even disappear in specimens from the north; whole of spire flamed with same brown colouration; interior of aperture tinged with blue in varying degrees.

Dimensions: Holotype, length 34 mm., breadth 19 mm., length of aperture 29 mm.

Type Locality: Trawled in 75 fathoms east of Stanwell Park, N.S.W.

Types: Holotype presented to Australian Museum, Sydney, where it is registered No. C. 63323, with one immature paratype; one paratype presented to National Museum of Victoria, Melbourne, one paratype in author's collection.

ENDEMOCONUS Iredale 1931, Rec. Aust., Mus., 18, p. 225, type species by original designation *howelli* Iredale.

howelli Iredale 1929, Rec. Aust. Mus., 17, p. 182, pl. 40, figs. 1, 8.

One dead specimen off Moreton Is., one south of Cape Moreton; one dead specimen off Broken Bay; two mature live and two smaller dead specimens in 70 fathoms off Stanwell Park.

A further specimen taken alive off Stanwell Park and a little more than half grown, shows strong spiral lirae encircling entire body whorl, and close examination shows faint traces of spiral lirae in places on a number of other specimens examined, as mentioned in original description, this feature tending to diminish or disappear entirely as maturity is reached. Striated specimen also tends towards a coronated spire, very small nodules on anterior end of body whorl, and has a fine chestnut periostracum. Coloration of this species is most variable, from pale chestnut to dark brown in live specimens, paler specimens having also a paler periostracum; patterning can vary from all-over blotched appearance of brown on whitish ground, to two or three distinct brown bands of blotches with spotting between, whilst others have fine wavy longitudinal brown lines; spire also can vary from being highly elevated as in type, to almost flat in some specimens sent for study from northern N.S.W. coast; interior of shell suffused with pale pink fading to white at either extremity.

RHIZOCONUS Morch 1852, Cat. Conch. Yoldi., p. 68, type species by subsequent designation (Iredale 1930, Mem. Q. Mus., 10, p. 80) *miles* Linne.

Rhizoconus advertex sp. nov.

(Pl. 1, fig. 1.)

Remarks: Two specimens of this shell were obtained N.N.E. of Cape Byron, N.S.W., one off Moreton Is., Q., and a number of others later sent for study from deep water also from off Moreton Is. The species bears a resemblance in some ways to *Floraconus angasi* Tryon, but the consistent and distinctive colour pattern coupled with the fairly flat spire, broad, sharply angled shoulders and straight sides, leave no doubt as to its separate identity, in addition to which the localities where these two species have been found do not appear to overlap.

Description: Shell rather small but typical of the genus, sides fairly straight, shoulders sharply angled, mouth narrow, straight and linear, spire slightly elevated but with prominent protoconch; protoconch is papillate, smooth and translucent, of three whorls. and merges gradually into main whorls, which number six; main whorls slightly concave, with five or six well defined spiral striations crossed by fine growth lines; rows of very fine punctate spots faintly discernible on body whorl in most specimens, merging into well defined oblique ridges at anterior end, spaces between these ridges also having a punctate appearance; coloration of a whitish background, in some cases suffused with pink in varying degrees, with revolving rows of square or elongated spots; outstanding feature of colour pattern consists of two narrow bands of pinkish-brown over-riding two bands of large irregular dark brown blotches; spire flamed with reddish brown, interior white, sometimes suffused with pink.

Dimensions: Length of type 30 mm., breadth 19 mm.

Type Locality: Trawled in 80 fathoms off Moreton Is., Q.

Types: Holotype presented to Australian Museum, Sydney, where it is registered No. C. 63348, with one paratype; a further two paratypes held by National Museum of Victoria, Melbourne.

LEPTOCONUS Swainson 1840, Treat. Malac., p. 312, type species by subsequent designation (Herrmannsen 1847, Ind. Gen. Malac., 1, p. 584). *amadis* Martini (= *amadis* Gmelin).

*Leptoconus illawarra** *sp. nov.*

(Pl. 1, fig. 2.)

Remarks: This species bears a fairly close resemblance to *Leptoconus eximius* Reeve from the Moluccas, the main difference being in the sculpture of the body whorl. Both shells are encircled by finely punctate lines, but whilst intervening spaces in this new species are quite flat and lines are only present from centre of body whorl to anterior end, intervening spaces in *eximius* Reeve consist of strong ridges and extend over whole of body whorl. Markings on this new species are also lighter and more orange in colour compared with the deep reddish-orange of *eximius.*

Description: Shell typical of the genus, conic, fairly straight sided, straight linear mouth, spire well elevated and concave; papillate protoconch of three whorls, smooth and translucent, and merges imperceptibly into body whorls, which number six; sculpture on spire usually of three fairly prominent spiral lirae an each whorl, crossed by well defined growth lines; anterior end of body whorl encircled by regularly spaced finely punctate lines, intervening spaces being flat at first but becoming more ridged and whole of this sculpture more oblique towards anterior end; colouration of encircling bands of orange-brown spots and blotches on off-white ground; spire similarly blotched, interior of aperture pinkish-orange, anterior end of columella white.

*An aboriginal word meaning "a pleasant place".

Dimensions: Holotype, length 29 mm., breadth 15 mm., length of aperture 22 mm.

Type Locality: Trawled in 75 fathoms east of Stanwell Park, N.S.W.

Types: Holotype presented to Australian Museum, Sydney, where it is registered No. C. 63349 with three paratypes; three paratypes presented to National Museum of Victoria, Melbourne; three paratypes in author's collection.

MAMICONUS Cotton & Godfrey 1932, South Aust. Nat., 13, p. 69, type species by monotypy *superstes* Hedley.

*Mamiconus minnamurra** *sp. nov.*

(Pl. 1, figs. 4a, b.)

Remarks: This species could conceivably grow larger than the holotype, there being no indication to show whether or not the shell is near maturity, and unfortunately, the lip of the holotype is broken. However it adds a most interesting species to this genus, formerly represented by the type species only.

Description: Shell typically conic in general appearance, spire slightly elevated, of six concave whorls and pronounced papillate protoconch of 1½ whorls; spiral whorls finely spirally striate, crossed by fairly prominent growth lines, with well defined shoulder present above each suture; sides of shell slightly concave towards anterior end; sculpture on body whorl of strongly defined spiral lirae, the whole crossed by very fine vertical lines; fine pale brown periostracum present; colour off-white with three irregular bands of brown blotches encircling body whorl; a row of brown spots just below shoulder, continuing between shoulder and suture on each whorl of spire; interior of shell has slight bluish tinge and protoconch translucent white.

Dimensions: Holotype, length 26 mm., breadth 14.5 mm., length of aperture 21 mm.

Type Locality: Trawled in 60 fathoms east of Botany Bay, N.S.W.

Types: Description based on holotype and one paratype, both presented to Australian Museum, Sydney, where they are registered No. C. 63350.

FAMILY TURRIDAE

TURRIS Muller 1766, Delic. Nat. Selectae, 1, p. 129, type species by original designation *Murex babylonius* Linne.

Turris binda† *sp. nov.*

(Pl. 1, fig. 7.)

Remarks: Only one specimen is so far known of this species, which appears to be by far the largest ever taken on the New South Wales coast, and a remarkable find in water so far south, the genus generally being considered strictly tropical.

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*An aboriginal word meaning "plenty of fish".

†An aboriginal word meaning "deep water".

Description: Shell large, heavily built, with tall slender spire, eleven main whorls, apical whorls missing; outer lip, although damaged, appears to have been sharp, without any folding or thickening, and sinus on peripheral keel; fourteen well defined raised revolving threads visible within aperture; anterior canal fairly long and straight, small portion missing; whorls sharply angled at periphery, with a broad concave shoulder and well rounded base; sculpture consists of numerous well defined revolving lirae, interspersed with finer threads, crossed by oblique growth lines veering to right above periphery and to left below it, where sculpture has a general granulated appearance; one well defined thread prominent just below suture, two other fairly smooth prominent threads form the peripheral keel, whilst sculpture generally tends to become smoother towards anterior end of shell; colour consists of chestnut spots on prominent thread below suture and on periphery, with more general blotching on lower part of main whorl; background and interior of aperture white.

Dimensions: Holotype, length 77 mm., breadth 25 mm., length of aperture 34 mm.

Type Locality: Trawled in 75 fathoms off Broken Bay, N.S.W.

Type: Holotype, the only known specimen, presented to Australian Museum, Sydney, where it is registered No. C. 63351.

TURRICULA Schumacher 1817, Essai nouv. syst. Vers. test., p. 217, type species by original designation *flammea* Schumacher 1817.

*Turricula murrawolga** *sp. nov.*

(Pl. 1, fig. 8.)

Remarks: Like the preceding species, this is another find of a genus normally regarded as only inhabiting tropical waters, and is once again indicative of the large field for further research which probably exists in the somewhat deeper waters of our coast. The species is strongly reminiscent of *Turricula kaderleyi* Lischke from Japan in general appearance.

Description: Shell fairly large, comparatively thin, regularly fusiform with long slender spire, main whorls eight in number; protoconch of two whorls, transparent, merging imperceptibly into first main whorl; canal long, straight and open, aperture approximately half total length of shell; outer lip thin and probably rounded, but damaged in all four specimens obtained; sculpture of slight evenly spaced revolving threads, crossed by faint growth lines which become a little more prominent on body whorl; posterior sinus just below suture, growth lines veering to right above it and to left below; one row of prominent elongated nodules present, evenly spaced round periphery of each whorl; colour white flamed with dark chestnut, a white patch present in centre and on top of each nodule, and a white band encircles body whorl midway between nodules and anterior end of shell; interior of aperture follows general colouration.

Dimensions: Holotype, length 57 mm., breadth 19 mm., length of aperture 28 mm.

Type Locality: All specimens trawled in 75 fathoms east of Broken Bay, N.S.W.

*An aboriginal word meaning "sheet of deep water".

Types: Owing to missing apical whorls on largest of four specimens obtained and damage to outer lip in all specimens, description based on series as a whole, of which holotype and one paratype presented to Australian Museum, Sydney, where they are registered No. C. 63352; one paratype presented to National Museum of Victoria, Melbourne; one paratype in author's collection.

AUSTROTURRIS Laseron 1954, Rev. N.S.W. Turridae, p. 6, type species by original designation *steira* Hedley.

steira Hedley 1922, Rec. Aust. Mus., 13, p. 224, pl. 42, f. 11.

One dead specimen in 45 fathoms east of Broken Bay.

MICANTAPEX Iredale 1936, Rec. Aust. Mus., 19, p. 319, type species by original designation *agnata* Hedley & Petterd.

agnata Hedley & Petterd 1906, Rec. Aust. Mus., 6, p. 220, pl. 37, f. 3.

Four dead specimens in 45 fathoms east of Broken Bay; one dead specimen east of Port Kembla.

profundis Laseron 1954, Rev. N.S.W. Turridae, p. 8, pl. 1, f. 13.

Two dead specimens east of Broken Bay.

EPIDIRONA Iredale 1931, Rec. Aust. Mus., 18, p. 225, type species by original designation *hedleyi* Iredale.

hedleyi Iredale 1931, Rec. Aust. Mus., 18, p. 225. New name for *Epideira striata* Hedley 1922 (not *E. striata* Gray 1827), Rec. Aust. Mus., 13, p. 230, pl. 43, figs. 18-20.

One dead specimen east of Broken Bay.

BENTHOFASCIS Iredale 1936, Rec. Aust. Mus., 19, p. 319, type species by original designation *biconica* Hedley.

biconica Hedley 1903, Mem. Aust. Mus., 4, p. 385, f. 98.

One dead specimen in 45 fathoms east of Broken Bay.

VEXITOMINA Powell 1942, Bull. Auck. Inst. Mus., 2, p. 77, type species by original designation *metcalfei* Angas.

coxi Angas 1867, Proc. Zool. Soc. Lond., 1867, p. 113, pl. 13, f. 15.

One live specimen in 45 fathoms off Broken Bay.

suavis Smith 1888, Ann. Mag. Nat. Hist., (6), 2, p. 305.

Two dead specimens off Botany Bay.

FILODRILLIA Hedley 1922, Rec. Aust. Mus., 13, p. 220, type species by original designation *tricarinata* Tenison-Woods.

tricarinata Tenison-Woods 1878, Proc. Linn. Soc. N.S.W., 2, p. 265.

Three dead specimens in 45 fathoms off Broken Bay.

AUSTROCARINA Laseron 1954, Rev. N.S.W. Turridae, p. 21, type species by original designation *recta* Hedley.

recta Hedley 1903, Mem. Aust. Mus., 4, p. 386, f. 99.

Two immature specimens in 45 fathoms off Broken Bay.

ETREMA Hedley 1918, J. Roy. Soc. N.S.W., 51, Suppl., p. M79, type species by original designation *aliciae* Melvill & Standen.

denseplicata tasmantis Laseron 1954, Rev. N.S.W. Turridae, p. 27, pl. 6, figs. 122-124.

One dead specimen off Botany Bay.

ASPERDAPHNE Hedley 1922, Rec. Aust. Mus., 13, p. 338. (New name for *Scabrella* Hedley 1918, not *Scabrella* Sacco 1890.) Type species by original designation *versivestita* Hedley.

hayesiana Angas 1871, Proc. Zool. Soc. Lond., 1871, p. 17, pl. 1, f. 17.

One dead specimen off Broken Bay.

VEPRECULA Melvill 1917, Proc. Malac. Soc., 12, pp. 141, 188, type species by original designation *sykesii* Melvill & Standen.

vepratica Hedley 1903, Mem. Aust. Mus., 4, p. 384, f. 97.

One dead specimen in 45 fathoms off Broken Bay.

SUBCLASS OPISTHOBRANCHIA

FAMILY SCAPHANDRIDAE

ADAMNESTIA Iredale 1936, Rec. Aus. Mus., 19, p. 333, type species by original designation *peroniana* Iredale (= *regularis* Gould).

thetidis Hedley 1903, Mem. Aust. Mus., 4, p. 395, f. 111.

Six live specimens off Botany Bay.

FAMILY ARMINIDAE

ARMINA Rafinesque 1814, Precis decouv. trav. Somiol, p. 30, type species by subsequent designation (Iredale and O'Donoghue 1923, Proc. Malac. Soc., 15, p. 217) *tigrina* Rafinesque (= *Pleurophyllidia* Meckel, 1823, Archiv. Anat. Phys., 8, p. 190, type species by monotypy *lineata*).

cygnea Bergh 1876, Malak. Blatt., 23, p. 9, pl. 1, figs. 1-7.

One live specimen in 50-60 fathoms east of Newcastle.

FAMILY PHILINIDAE

PHILINE Ascanius 1772, K. Vet. Acad. Handl. (Stockh.), 33, p. 331, type species by monotypy *aperta* Linne.

angasi Crosse & Fischer 1865, J. de Conch., 13, p. 38, pl. 2, f. 8.

One live specimen in 32 fathoms east of Terrigal.

CLASS SCAPHOPODA

FAMILY DENTALIIDAE

DENTALIUM Linne 1758, Syst. Nat. ed. 10, p. 758, type species by subsequent designation (Montfort 1810, Conch. Syst., 2, p. 55) *elephantinum* Linne.

S.g. *EPISIPHON* Pilsbry & Sharp 1897, Man. Conch. (Tryon), 17, pp. 31, 117, type species by subsequent designation (Suter 1913, Man. New Zeal. Moll., p. 821) *sowerbyi* Guilding.

virgula Hedley 1903, Mem. Aust. Mus., 4, p. 328, f. 2.

Numerous specimens obtained, some alive, in 74-75 fathoms east of Botany Bay.

CLASS CEPHALOPODA

SUBCLASS DIBRANCHIA (= COLEOIDEA)

FAMILY SEPIIDAE

SUBFAMILY SOLITOSEPIINAE

DECORISEPIA Iredale 1926, Aust. Zool., 4, p. 193, type species by original designation *rex* Iredale.

rex Iredale 1926, Aust. Zool., 4, p. 193, pl. 22, f. 9-10.

Two live specimens in 76-80 fathoms east of Lake Macquarie.

GLYPTOSEPIA Iredale 1926, Aust. Zool., 4, p. 191, type species by original designation *opipara* Iredale.

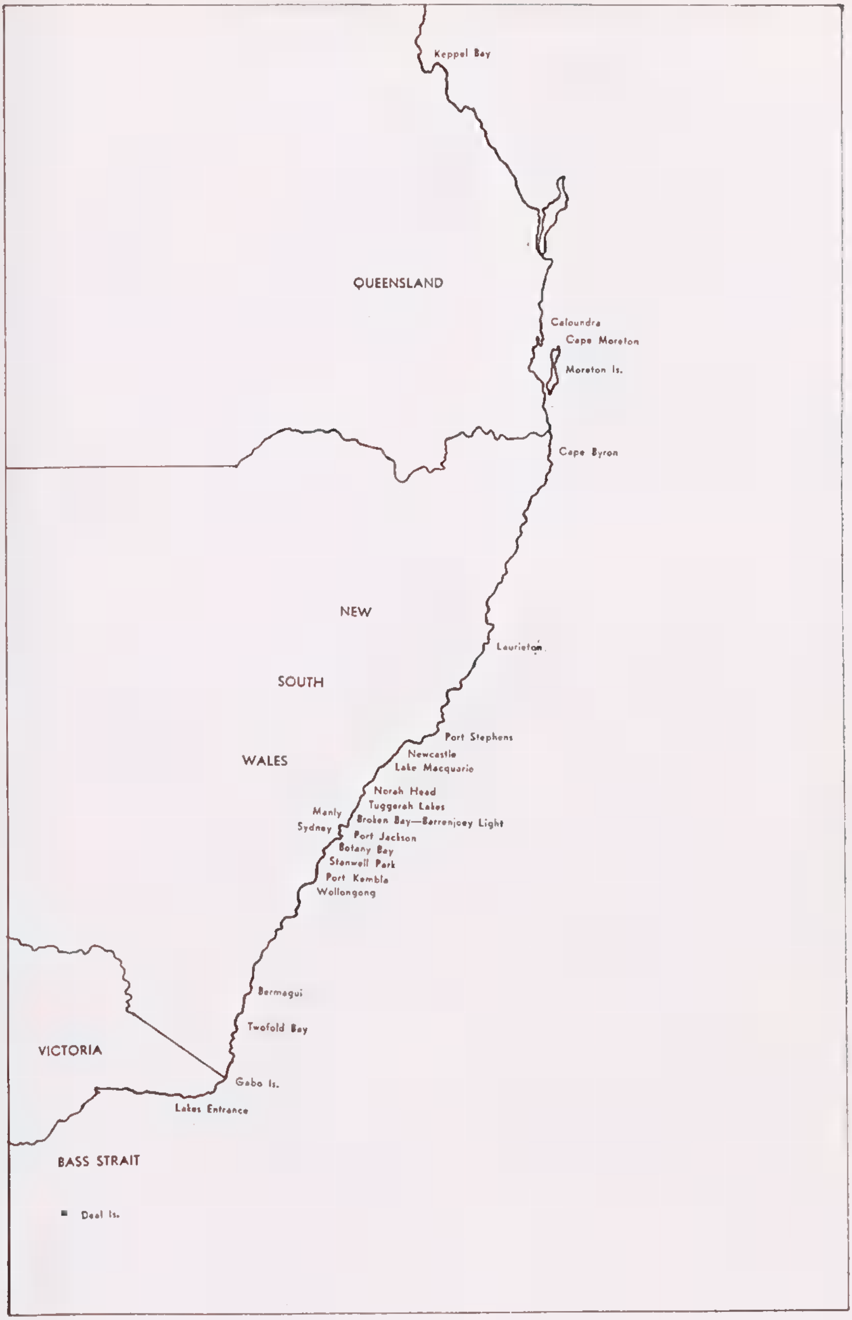
cultrata Hoyle 1885, Ann. Mag. Nat. Hist., (5), 16, p. 198.

Two live specimens in 156-160 fathoms east of Newcastle.

ARCTOSEPIA Iredale 1926, Aust. Zool., 4, p. 193, type species by original designation *limata* Iredale.

versuta Iredale 1926, Aust. Zool., 4, p. 193, pl. 23, f. 5-6.

Twelve live specimens in 76-80 fathoms east of Lake Macquarie; one live specimen in 96 fathoms east of Tuggerah Lakes.


Keppel Bay
QUEENSLAND
Caloundra
Cape Moreton
Moreton Is.
Cape Byron
NEW
SOUTH
WALES
Laurieton
Port Stephens
Newcastle
Lake Macquarie
Norah Head
Tuggerah Lakes
Manly
Sydney
Broken Bay—Barrenjoey Light
Port Jackson
Botany Bay
Stanwell Park
Port Kembla
Wollongong
Bermagui
Twofold Bay
VICTORIA
Gabo Is.
Lakes Entrance
BASS STRAIT
Deal Is.

COMPARATIVE TABLE OF CHARACTERS

Genus *Liolophura*. Species:	*japonica*	*japonica*, form *tenuispinosa*°	*gaimardi*	*gaimardi*, form *platispinosa*°	*hirtosa*
Insertion Plates	8, 10, 11, 12-1-0	11-1-0	8, 10, 11-1-0	8, 10-1-1 or several	10-1-10
Callus VIII	Smooth, no fissure. Sometimes one slight and narrow lateral projection Lateral region little pectinated.	Very faintly cross-hatched One (or two) lateral fissures, rather deep on each side Pectinated	Smooth, no fissure Sometimes one slight and narrow lateral projection Not pectinated	No callus in the strict sense Two spec., each with two deep fissures on each side. One spec., with 7 short lamellae superficial, sometimes none in the intermediate region Teeth well pectinated	Smooth, flat sometimes lightly cross-hatched One spec., with one inclined lamella and one curved lateral notch. One spec., with inclined and oblique lamellae. Little pectinated
Sculpture	Rather smooth, somewhat granular.	Rather smooth, somewhat granular	Delicate granules, irregularly elongated in radial rows	Irregular granules	Irregular granules rather thick, elongated in radial rows
Zones of Growth: Lateral Area	More or less connected and close together.	Rather large and thick	Large, rather thick	Large	Large and thick
Jugum and Median Area	More or less smooth	Large and flat	Narrow	Narrow	More or less large, flat
Girdle, upper surface, large spines	Of equal length. More or less thick Cylindrical or flattened.	Of equal length. Slender, cylindrical	Of different lengths, more or less cylindrical	Of different lengths, much enlarged	Of equal length, large and short
Dimensions in mm.	35 x 21: Lischke 36 x 25, 68 x 43: Taki 22.5 x 16, 32 x 19: Leloup	65 x 48, 70 x 47, 74.5 x 47: Leloup	45 x 25: Iredale & Hull 23.5 x 16, 35 x 27.5: Leloup	18.5 x 13, 21 x 11, 30 x 18.5: Leloup	65 x 35: Hull, max. 46 x 28.5, 52 x 30, 40 x 29: Leloup
Origin	Japan and vicinity	Indo-China and vicinity	Australia to the Malayan Archipelago, Atlantic coast of Africa.	Shikok (Japan) Tonkin	From South-West Australia to the Abrolhos and Dirk Hartog Islands

° See E. Leloup, 1939, Bull. Mus. roy. Hist. Nat. Belg., 15, 1.

SPECIES OF THE GENUS *LIOLOPHURA* PILSBRY, 1893 (MOLLUSCA, POLYPLACOPHORA)

By EUGENE LELOUP. D.Sc.*

The genus *Liolophura* includes particularly three species, *L. japonica* (Lischke, 1873), *L. gaimardi* (Blainville, 1825) and *L. hirtosa* (Blainville, 1825) representatives of which display many analogies between each other: the oval, elongate form; the shell little elevated; the sculpture diffentiated on the median and lateral areas, less pronounced on the lateral areas and composed of granules, more or less thick, abundant and regularly arranged; the growth striae well marked; the coloration rather dull, varied by more or less extensive lighter regions, with a narrow brown band always present on the jugum of valves II-VII, valve I being divided into three sections, of which the middle, more or less wide, is light coloured. The perinotum is covered on the upper surface with two kinds of spines; the most abundant kind are of varied shape, generally thick, coloured and sculptured with fine, longitudinal granulose ribs; the others are small, slender, elongate, cylindrical, with very fine longitudinal ribs, and plentifully covered with brown pigment; at its marginal edge, the perinotum bears solid, elongate spines, and on its lower surface, rectangular scales which are thick and curved.

In order to avoid the description of the species which have, moreover, been given perfectly by other authors, it seemed to be more useful to prepare a comparative table in which the distinguishing characters of the species are given, and to follow this with the references and figures, a record of the material observed, the geographical distribution of the species under consideration, and finally some remarks suggested by the study of the specimens.

Liolophura japonica (Lischke, 1873)
(Text figs. 1, 2 and 5a, Pl. 3, fig. 1.)

Liolophura japonica (Lischke, 1873). Taki, Isao, 1938, Sci. Rep. Tohoku Imp. Univ. (4), Biol., 12, No. 3, pp. 398-404, pl. 15, fig. 3, pl. 32, figs. 15, 16, pl. 33, figs. 1-8, pl. 34, figs. 1-4 (bibliography and synonymy).

MATERIAL OBSERVED:

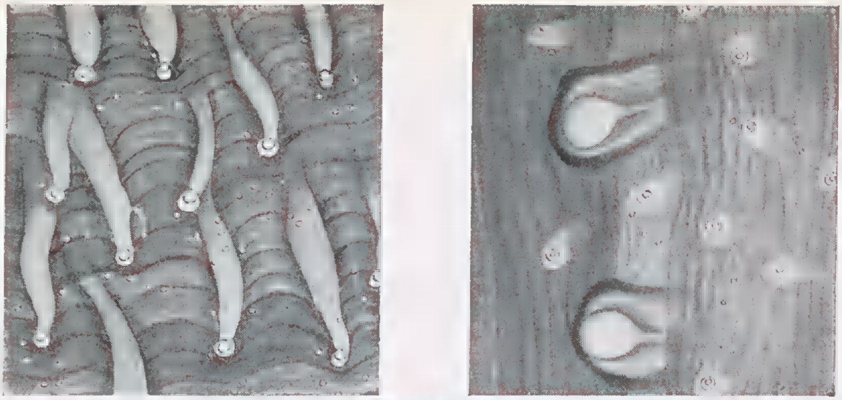
Collection of the Institut royal des Sciences naturelles, Belgium:

Japan (2 specimens, largest 18 x 20.5 mm., curled up). Hirado-Hizen (3 specimens, largest 50 x 26 mm., girdle compressed). Fukura, Awaji (2 specimens, largest 38 x 23 mm., a little curled and girdle compressed). Enoshima (1 specimen, 21 x 14 mm., curled up).Locality? (1 specimen, 26 x 20 mm., curled up).

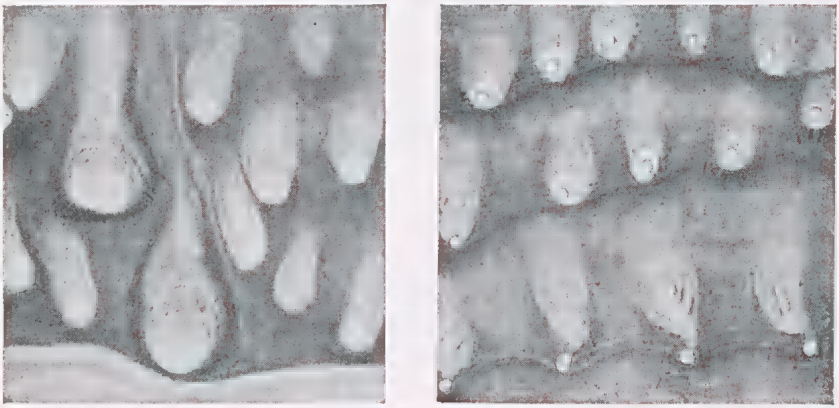
(Under the name var. *tessellata*): Japan (5 specimens, largest 27.5 x 14 mm., girdle compressed, 22 x 22 mm., curled up and compressed). Yokohama (1 specimen, 34 x 17 mm., girdle compressed).

(Under the name form *tenuispinosa*): See E. Leloup, 1939, Bull. mus. roy. Hist. nat. Belg., 15, 1.

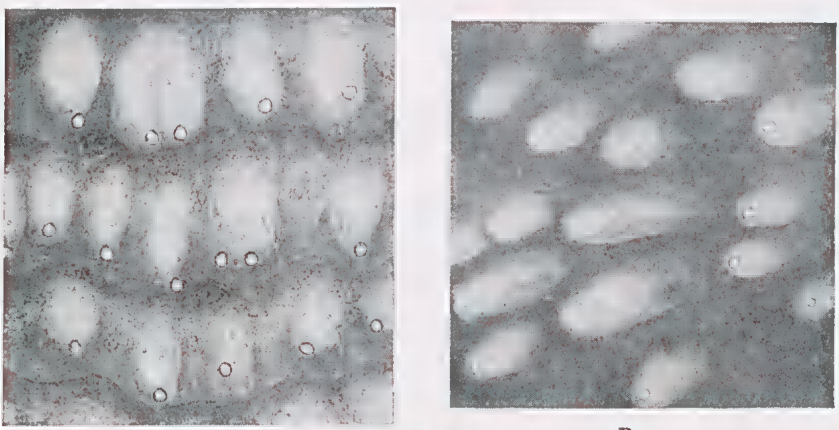
*Institut royal des Sciences naturelles, Brussels, Belgium.



A. FIGURE 1. B.



A. FIGURE 2. B.



A. FIGURE 3. B.

PLATE 3.—AESTHETES (Mag. x 120).

Figure 1: *Liolophura japonica* (Lischke, 1873), form *tenuispinosa.*
A—Median area. B—Lateral area.

Figure 2: *Liolophura gaimardi* (Blainville, 1825).
A—Median area, pleural region. B—jugal region.

Figure 3: *Liolophura gaimardi* (Blainville, 1825), form *platispinosa.*
A—Median area, jugal region. B—Lateral area.

Collection of the British Museum (Natural History), London:

Misaki, sea-level, May, 1921, V. Insole Esq., No. 43,1921-12-20, 254, 257 (1 specimen, 22.5 x 16 mm.) No. 52, 1921-12-20, 298, 307 (3 specimens, largest 19 x 13.5 mm.). Enoshima, Dr. Anderson, No. 80-12-10, 284-5 (2 specimens, largest 30 x 17 mm., girdle compressed).

Collection of the Zoological Museum, Hamburg:

Fokien, China, 9-IX-1912, Konsul G. Sumssen (20 specimens, largest 34 x 20 mm., girdle compressed, (form *tessellata*). North Formosa, coll. Warburg (2 specimens, largest 27 x 20 mm.).

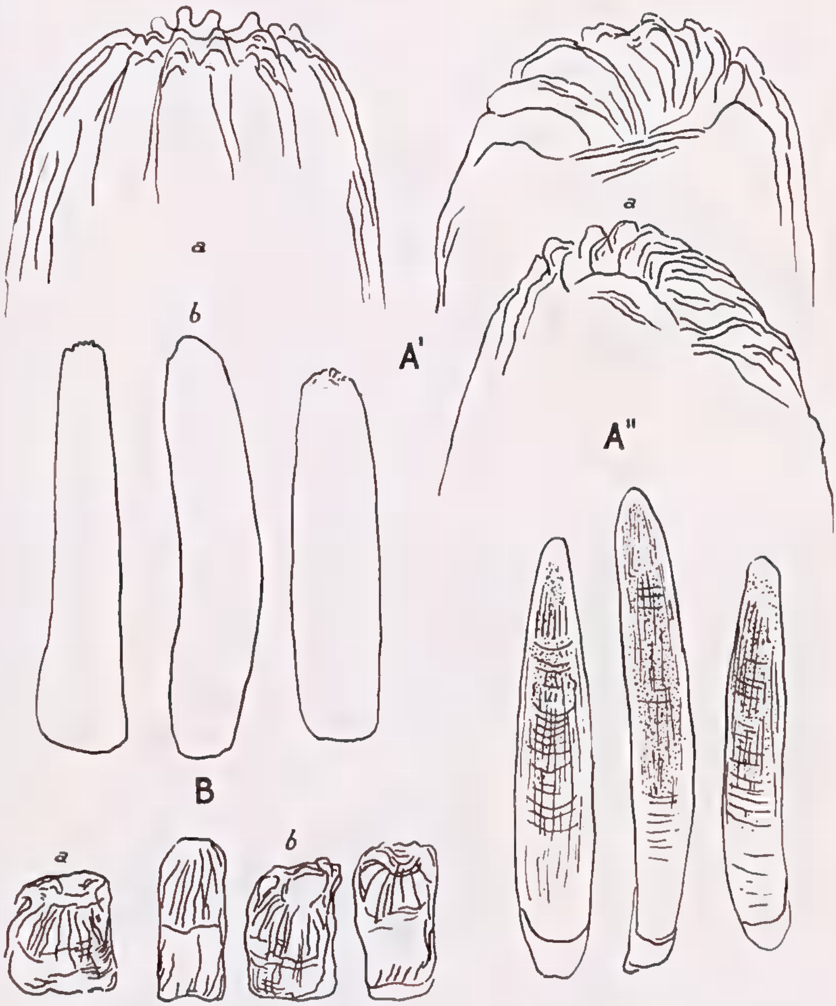


Figure 1: *Liolophura japonica* (Lischke, 1873). Specimen from Hirado-Hizen. Girdle Elements: A—Upper surface: A1—Thick spines. *a*—Extremities (x 350), *b*—(x 55). A11—Small spines (x 350). B—Lower surface: (x 350). *a*—in the centre, *b*—near the margin.

GEOGRAPHIC DISTRIBUTION:

See Isao Taki (1938): Japan and vicinity.

Liolophura gaimardi (Blainville, 1825)

(Text figs. 3, 5b, Pl. 3, fig. 2.)

Liolophura gaimardi. Iredale, T., & Hull, A. F. B., 1926, Aust. Zool. 4, p. 262, pl. 37, figs. 13-16, 19, 31 (bibliography and synonymy). Pilsbry, 1894, Proc. Acad. Nat. Sci. Philadelphia, p. 87. Casto de Elera, Fr., 1896, Cat. Sist. Fauna Philipinas, 3, p. 442. Tate, R., and May, W. L.,

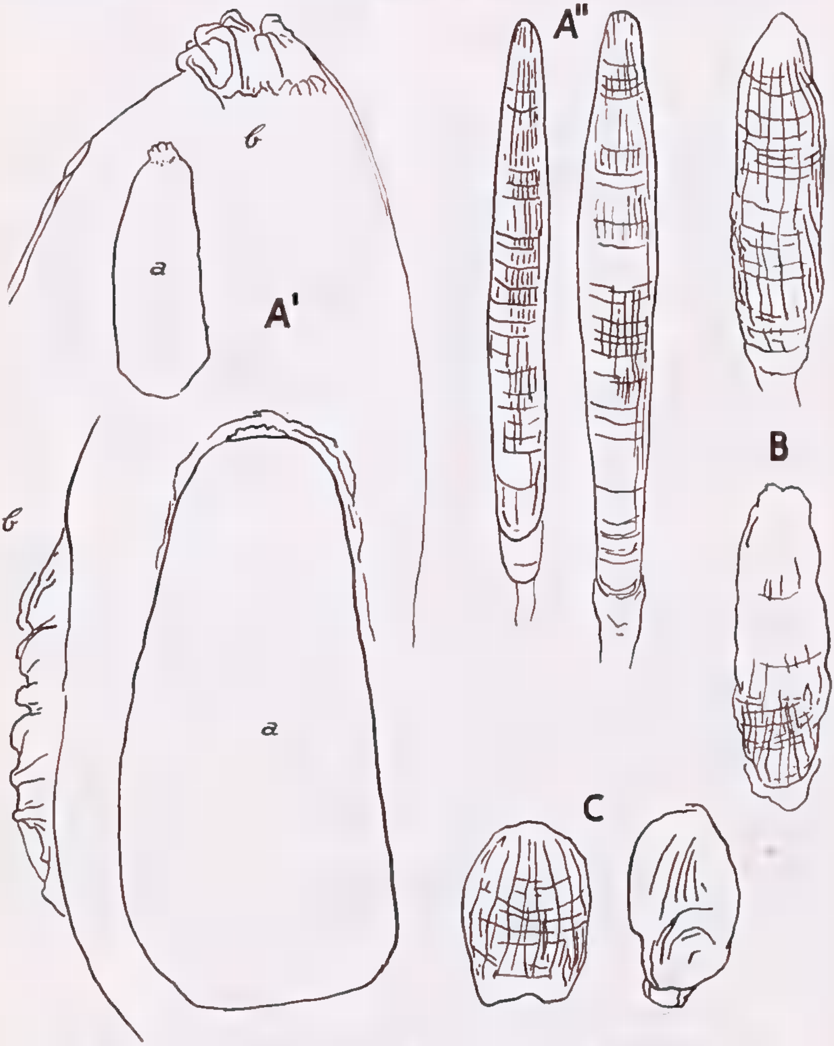


Figure 2: *Liolophura japonica* (Lischke, 1873), var. *tessellata* Pilsbry, 1893. Specimen from North Formosa. Girdle Elements: (Mag. x 350, *a*— x 55.) A—Upper surface: A1—Two thick spines, *b*—their respective extremities. A11—Small spines. B—Marginal edge, scaly-spines. C—Lower surface, scales.

1901, Proc. Linn. Soc. N.S.W., 26, p. 415. Hidalgo, J. G., 1904-1905, Catal. Mol. testaceos Filipinas, Jolo y Marianas, 1, p. 272. Nierstrasz, H., 1905, Chitonen Siboga-Exp., 48, pp. 108, 110; 1905, Notes from the Leyden Mus., 25, pp. 154-155, pl. 10, figs. 20, 21. May, W. L., & Torr, W. G., 1912, Pap. Proc. Roy. Soc. Tasmania, p. 40. Ashby, E., 1922, Trans. Proc. Roy. Soc. S. Aust., 46, p. 581; 1926, Rept. Austral. Ass. Adv. Sci., 17,

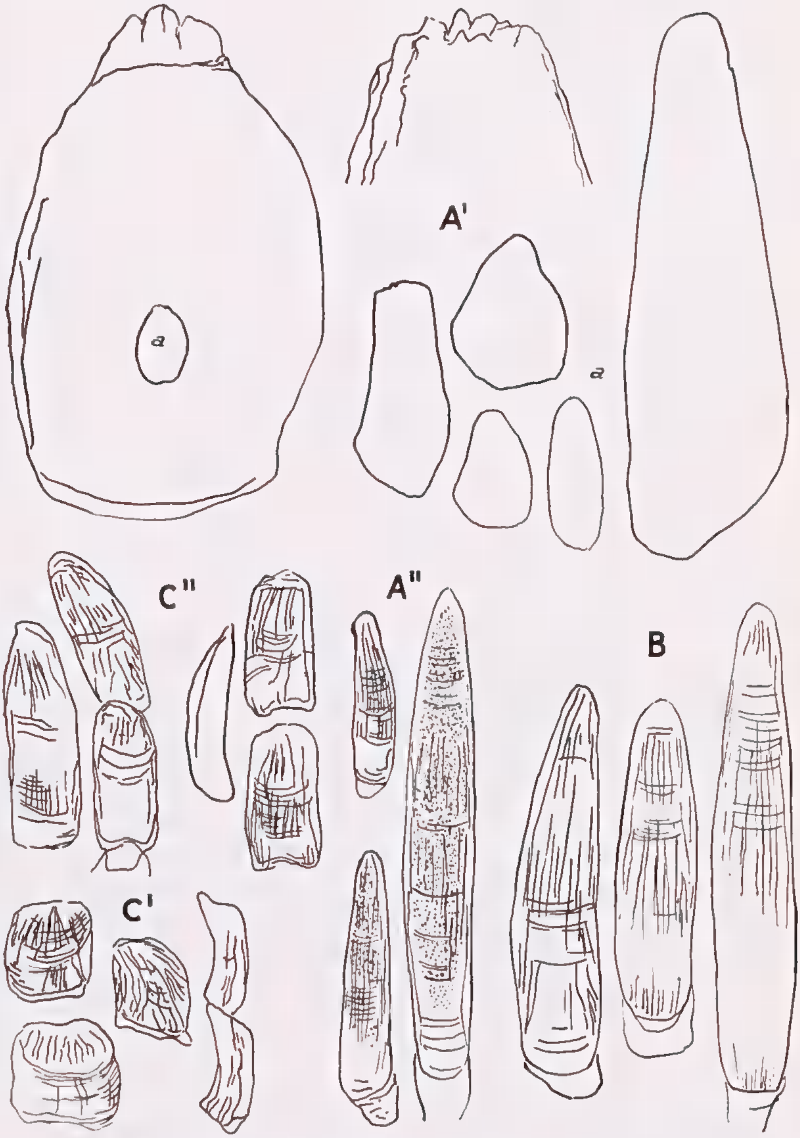


Figure 3: *Liolophura gaimardi* (Blainville, 1825). Girdle Elements. (Mag. x 350). A—Upper surface: A1—Scales (*a*— x 55). A11—Small pigmented spines. B—Marginal edge, scaly-spines. C—Lower surface, scales: C1—in the centre, C11—near the marginal edge.

pp. 380, 384, 386, 388-9. Bergenhayn, J. R. M., 1930, Kungl. Sv. Vetens. Handlingar, 9, p. 32, pl. 8, figs. 76, 77; 1937, Arch. F. Mollusk, 69, pp. 44-48, figs. 1, 2. Allan, J., 1950. Australian Shells, p. 238, fig. 55 (6a).

Acanthopleura quatrefagei Rochebrune. Pisbry, H., 1892, Man. of Conch., 15, p. 96. Sykes, E. R., 1894, Proc. Mal. Soc. Lond., 1, p. 135. Thiele, J., 1909, Zoologica, 22, p. 8.

Acanthopleura brevispinosa (Sowerby), pars, Ashby, E., 1931, Ann. South African Mus., 30, p. 53.

Liolophura queenslandica Pilsbry. Iredale, T., & Hull, A. F. B., 1926, Aust. Zool., 4, p. 263, pl. 37, figs. 23-25, 30, 32 (bibliography). Hull, A. F. B., 1924, Proc. Roy. Soc. Queensland, 36, p. 109.

MATERIAL OBSERVED:

Collection of the Institut royal des Sciences naturelles of Belgium:

Australia (10 specimens, largest 35 x 23 mm.). South Australia (2 specimens, 33 x 19 mm., girdle compressed, 32 x 18.5 mm. extended). Sydney (1 specimen, 28 x 15.5 mm.). Wooloomooloo (5 specimens, largest 34 x 20 mm., a little curled). Port Jackson (2 specimens, 35 x 20 mm., extended). Mosman Bay (1 specimen, 20 x 17 mm.). Rawak, Papouasie (2 specimens, largest 20 x 14.5 mm., a little curled). British New Guinea (1 specimen, 22 x 14 mm.). Co-type of *A. quatrefagei* (1 specimen, 13.5 x 7.5 mm.). Locality? (2 specimens, largest 32 x 20 mm., extended).

(Under the name form *platispinosa*): See E. Leloup, 1939, Bull. Mus. Hist. Nat. Belg., 15, 1.

Collection of the British Museum (Natural History), London:

Port Jackson, Dr. J. C. Cox, No. 93, 10, 28-36, 7 (2 specimens, 23.5 x 16.5 mm., extended, 25 x 15.5 mm.), No. 93-10-38, 38 (1 specimen, 35 x 27.5 mm.).

GEOGRAPHIC DISTRIBUTION

In the Pacific Ocean from Australia to the Malay Archipelago; Atlantic coast of Africa.

Liolophura hirtosa (Blainville, 1825)

(Text figs. 4, 5c.)

Liolophura hirtosa (hirtosus). Ashby, E., 1923, Trans. Proc. Roy. Soc. S. Aust., 47, p. 230; 1926, Rept. Austral. Ass. Adv. Sci., 17, pp. 379-380, 384, 387; 1928, Trans. Proc. Roy. Soc. S. Aust., 52, p. 180; 1929, J. Roy. Soc. W. Aust., 15, p. 52. *Clavarizona hirtosa.* Hull, A. F. B., 1923, Aust. Zool., 3, pp. 199-201 (bibliography and synonymy). Iredale, T., and Hull, A. F. B., 1926, Aust. Zool. 4, pp. 261-262, pl. 37, figs. 9-12, 17, 21. Allan, J., 1950, Australian Shells, p. 239, fig. 56 (10b).

MATERIAL OBSERVED:

Collection of the Institut royal des Sciences naturelles of Belgium:

Western Australia (1 specimen, 32 x 21 mm.). King George's Sound (1 specimen, co-type of *georgianus* Quoy & Gaimard, large valves separated; 2 specimens, 46 x 28.5 mm., and 32 x 26mm., curled up). King Island (1 specimen, co-type of *georgiana* Quoy & Gaimard, 39.5 x 30 mm.).

Fremantle (1 specimen, 52 x 30 mm.). Locality? (2 specimens, largest 40 x 29 mm.).

GEOGRAPHIC DISTRIBUTION:

Southern and Western Australia.

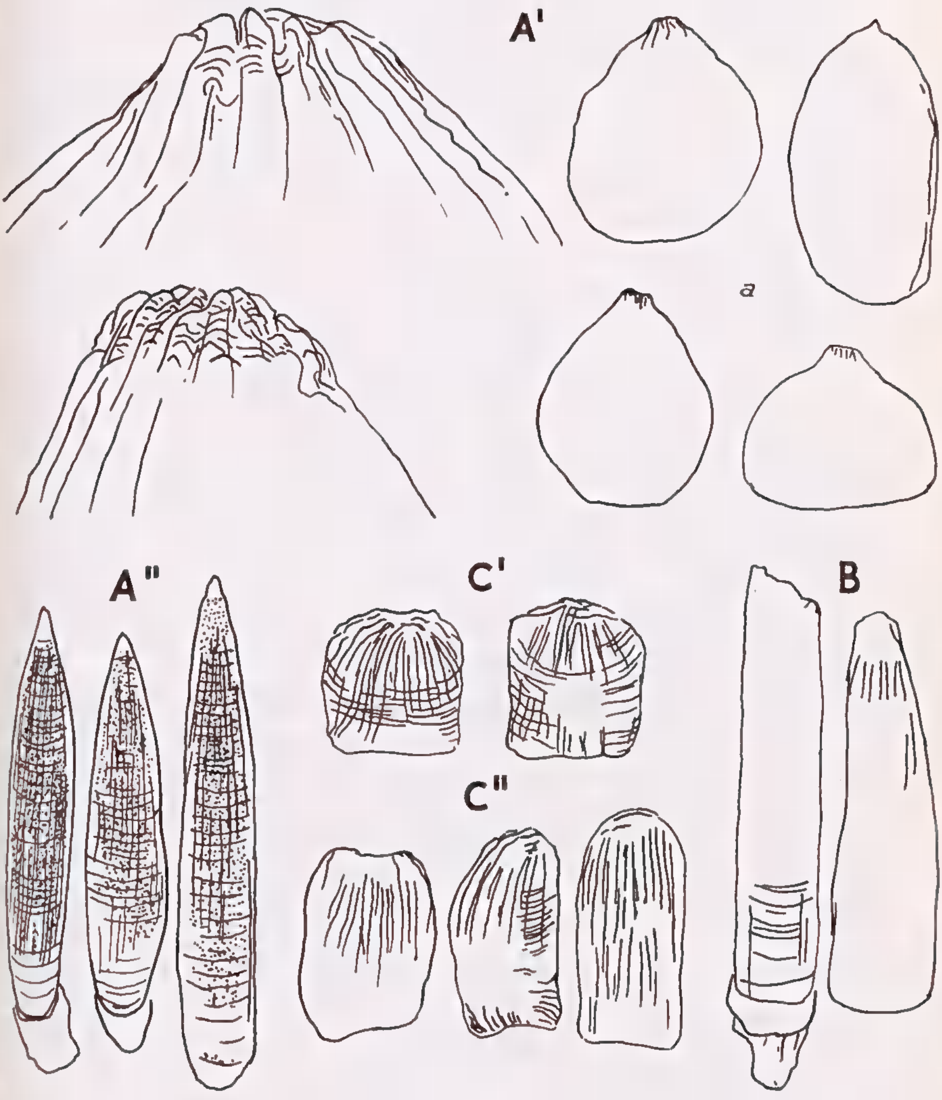


Figure 4: *Liolophura hirtosa* (Blainville, 1825). Girdle Elements: (Mag. x 350, *a* x 55. A–Upper surface: A1–Scales. A11–Small pigmented spines. B–Marginal edge, scales. C–Lower surface: C1–in the centre, C11–near the marginal edge.

REMARKS.

1. H. Pilsbry (1892) created the var. *tessellata* for the specimens of *L. japonica* which have the upper face of the girdle covered with enlarged spines (text fig. 2); regarding this it must be stated that, in the species *japonica*, spines of this type are subject to notable variation. I had the opportunity of examining two specimens from northern Formosa, the girdles of which carried enormously thick spines. This fact is probably due to an environment rich in limestone, for the valves are likewise strongly encrusted; other specimens from Fokien (China) have similarly thickened and deformed spines, especially those from the lighter coloured zones of the girdle. According to H. Pilsbry, these chitons belong to the variety *tessellata;* however between these specimens with very thick spines, and those with not very thick spines are ranged specimens with spines of intermediate thickness. Thus, there is no well established delimiting point between the two extremes and the variety cannot always be determined very precisely.

In his recent work on the chitons of Mutsu Bay, Isao Taki (1938) makes the same statement and acknowledges the impossibility of separating the varieties of the species.

2. Among the *Liolophura* of different provenances, I have found (E. Leloup, 1939) specimens in which the perinotum bears very abundant spines of uniform length, short, slender, cylindrical, with rounded and white ends; light or dark, they are grouped in alternate regions. This girdle recalls that which is characteristic of *Acanthochiton spiniger,* form *haddoni* Winkworth. The characters of the shell are those of *L. japonica.* This form can be separated under the name *tenuispinosa,* only because of its girdle, its localised habitat in the Indo-Chinese region, and principally because of the lack of specimens with intermediate characters (see E. Leloup, 1939).

3. Among the specimens of *L. japonica* which have been examined, one well-developed specimen was found. The shell, which is in good condition, is of a rather uniform brown colour on the outside of the light coloured bands which extend laterally to the brown jugal band. The valves show, in addition to the structure on the lateral areas of not very numerous and not very regular granules, rather deep grooves delineating longitudinal ribs. On the median areas these ribs are developed mainly on the posterior half of these areas, where they are curved; on the anterior half they have been levelled by erosion and only the lowest parts of the grooves are evident.

4. *L. gaimardi* is known from eastern Australia, and, according to H. Nierstrasz (1905) from Australia to the Indo-Malayan archipelago. Among the Amphineura of the Zoological Museum, Hamburg, there are two specimens from Shikok (Japan); also the Institute royal des Sciences naturelles, Belgium, possesses a specimen from Tonkin. Although they belong to the species *gaimardi,* the characteristics of which they all show, these three specimens are distinguished by the investment of the girdle's upper side, which consists of spines of unequal length, but all considerably enlarged and recumbent. This peculiarity, and the new habitat of the species caused me to regard these specimens as belonging to a new form, *platispinosa* (see E. Leloup, 1939).

5. E. Ashby (1926) very wisely pointed out that the creation of a new genus for the species *L. hirtosa* by A. F. B. Hull (*Clavarizona* Hull,

1923) is hardly justified by the fact that the spines are enlarged in the form of scales on the upper face of the girdle. These elements really do not differ from those of other *Liolophura* except in dimensions, and among the short, enlarged spines of *L. gaimardi platyspinosa*, similar elements can be found. Under strong magnification, they are revealed not as scales covered by ribs on the upper side, but as spines completely sculptured with longitudinal ribs; moreover their arrangement on the girdle is not regular like that of the scales of the Chitoninae and the Ischnochitoninae; their implantation is that of the spines in the sheaths in swellings.

6. In 1894, H. Pilsbry has recognised among specimens of *L. gaimardi*, some of larger size than was previously known for the species, with a uniformly black girdle exhibiting shorter spines than those of the typical *gaimardi* girdle, and he has created for them the variety *queenslandica*. In 1923, A. F. B. Hull redescribed the variety with details of the sculpture which he contrasted with that of typical *gaimardi*. Having admitted that the characters of the sculpture have often deteriorated through erosion and are difficult to recognise, especially in fully grown individuals, he agreed to examine these characters only on juveniles in good condition. The specimens differed only as to the length of the spines; the other characters of the spines and their arrangement remained the same. This single (and not very important) difference does not justify the creation of the variety, a creation which otherwise is not much mentioned in literature.

7. Various authors have expressed their doubts as to the validity of the species *Acanthopleura quatrefagei* Rochebrune, 1881, and regarding its habitat, H. Pilsbry (1893) has placed in among the insufficiently described chitons. R. Sykes (1894) hesitated to include it in his list of Polyplacophora from South Africa. J. Thiele (1909) in his synonymy of certain species of Rochebrune, recognised it as *A. (Liolophura) gaimardi* and he corrected the name *A. quatrefagei* to the latter. However, comparatively recently E. Ashby (1931) placed *A. quatrefagei* in the synonymy of *A. brevispinosa*. The examination of one co-type of *A. quatrefagei* permits me to confirm the opinion of Thiele and has led me to place this species of Rochebrune in the synonymy of *L. gaimardi*, in particular that of its form *platispinosa*, of which it has the characteristic shape, sculpture, coloration and perinotum.

8. Among the *L. gaimardi* preserved at the Institut royal des Sciences naturelles, Belgium, there is a specimen from "British New Guinea" (fig. 5, B3). Its shape not well developed (22 x 14 mm.), its girdle is covered on the upper side with spines, more tenuous than those of the Australian *L. gaimardi*, and it corresponds to the form *queenslandica*. When disarticulated, valve VIII is seen to have a callus, very superficially but regularly and completely pectinated (fig. 5, B3) with moreover, one deep fissure laterally on the left and two fissures on the right. Because of this conformation, the specimen comes singularly close to the genus *Acanthopleura*. However its not very strong pectination and the irregular fissures constitute rather indefinite characters; moreover the form of the callus and the peculiarities of the perinotum places this chiton with *L. gaimardi*, of which it possesses the form, coloration and sculpture.

9. In one specimen of the species *hirtosa* preserved at the Institut royal des Sciences naturelles, Belgium, but of unknown origin (fig. 5, C1) the valves are eroded to the point of being disarticulated in the median

area; the intervals thus produced are filled up with an unusual growth of the investment of the intervalve prolongations of the perinotum, on which spines are inserted close together, similar to those of the upper side of the girdle but smaller. This fact has been discovered and recorded by P. Dupuis in the Bulletin No. 7 of the Museum d'Histoire naturelle, of Paris, 1917. As indicated briefly in the comparative table, (p. 38), the callus of valve VIII is subject to variation (fig. 5). Smooth, large and flat on a typical *L. gaimardi* (fig. 5, B1), it has pectinations on the lateral regions in typical *L. japonica* (fig. 5, A1), weak and recumbent lamellations on *L. hirtosa* (fig. 5, C1), two lateral fissures next to the pectinated regions on *L. japonica tenuispinosa* (fig. 5, A2) and finally several fissures and pectinated teeth on *L. gaimardi platispinosa* (fig. 5, B2). These observations have been made on a relatively limited number of specimens; it would be interesting if they could be extended to a larger number of specimens. They seem to prove the very close relationship between *Liolophura* and *Acanthopleura*. The degree of relationship is most pronounced among the specimens from areas remote from the range of the

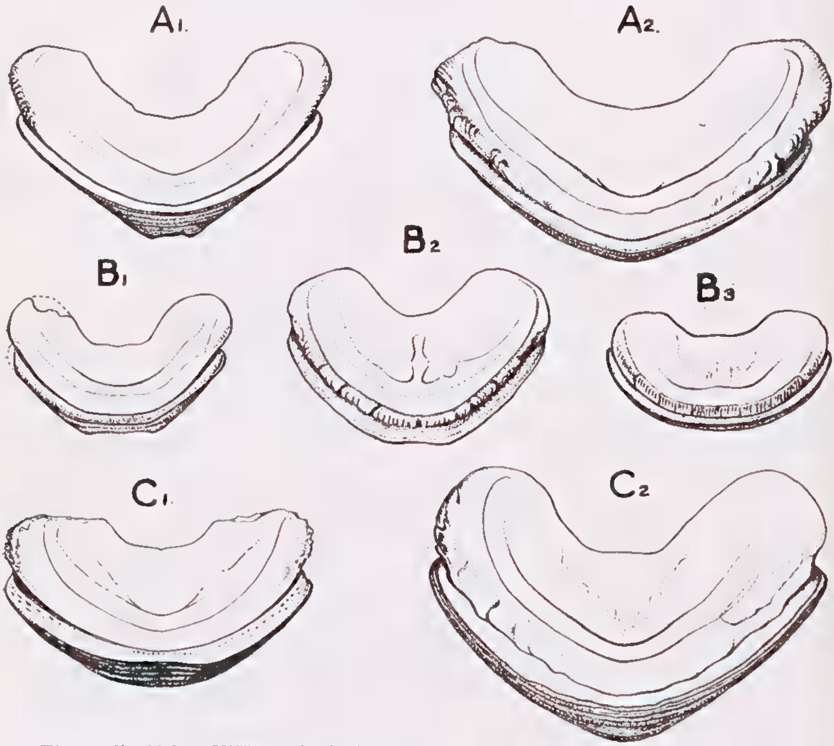


Figure 5: Valve VIII of *Liolophura spp.* Lower surface.

A–*L. japonica* (Lischke, 1837).
A1–Typical, locality unknown. A2–form *tenuispinosa*, Poulu Dama.

B–*L. gaimardi* (Blainville, 1825).
B1–Typical, Australia. B2–form *platispinosa*, Tonkin. B3–form *queenslandica*, British New Guinea.

C–*L. hirtosa* (Blainville, 1825).
C1–Origin unknown. C2–Australia.

typical species: in *L. japonica tenuispinosa* from Indo-China, *L. gaimardi platispinosa* from Japan and Tonkin, *L. gaimardi queenslandica* from "British New Guinea" (= Papua). *L. gaimardi platispinosa* has the posterior valve of an *Acanthopleura*, the fissures of which are more slanting and the teeth shorter; moreover the position of the insertion plate is more turned in and is much exceeded by the tegmentum (fig. 5, B2).

10. *Aesthetes. L. japonica* form *tenuispinosa* (Pl. 3, fig. 1). The disposition of the narrow elongated aesthetes (being a terminal macroaesthete accompanied by 5 to 8 microaesthetes rather much elongated) is not very regular. It is influenced by the growth of the tegmentum, for it is rather concentric. Very often the aesthetes are divided into two and these elements emerge at two different levels. On the lateral areas the disposition is even less regular than on the median areas. The extrapigmentary eyes intermingle in great numbers with the aesthetes; it is not uncommon to see two or three adjoining; they are also placed in concentric series.

L. gaimardi (Pl. 3, fig. 2). My observations regarding the structure of the tegmentum were made difficult by the erosion of the valves; however, one specimen of medium size and less damaged, did show aesthetes similar to those of *L. japonica.* Although the presence or the number of microaesthetes was not revealed, the disposition of the aesthetes is rather regular on the jugal regions where they are in level, transverse rows; in the pleural and lateral regions, their disposition is more diffuse and numerous extrapigmentary eyes emerge between the aesthetes. The zones of growth are strongly separated by furrows in which no aesthetes are apparent.

L. gaimardi platispinosa (Pl. 3, fig. 3). A decalcified valve, taken from one specimen in very good condition from Shikok (Japan) showed that the aesthetes are lengthened by ramifying in oval cavities, the extremities of which are turned towards the umbo and allow the macroaesthetes to become level, and from whose circumference the microaesthetes come off, very small, on long peduncles and surrounding the macroaesthetes; the microaesthetes, which are very slender and very easily displaced, generally appear to number about six per aesthete. The aesthetes are rather regularly placed in the median areas, where they are level in transverse rows and often in groups of two or three. On the lateral areas, their disposition is less regular, more or less in quincunx, and cut across by large zones of growth. In the lateral areas and the pleural areas, the extrapigmentary ocelli are level among the aesthetes.

ACKNOWLEDGMENTS:

The assistance of Mr. P. E. Schwerin in translating the article into English and of Mr. F. J. Beeman in preparing the line-drawings is gratefully acknowledged.

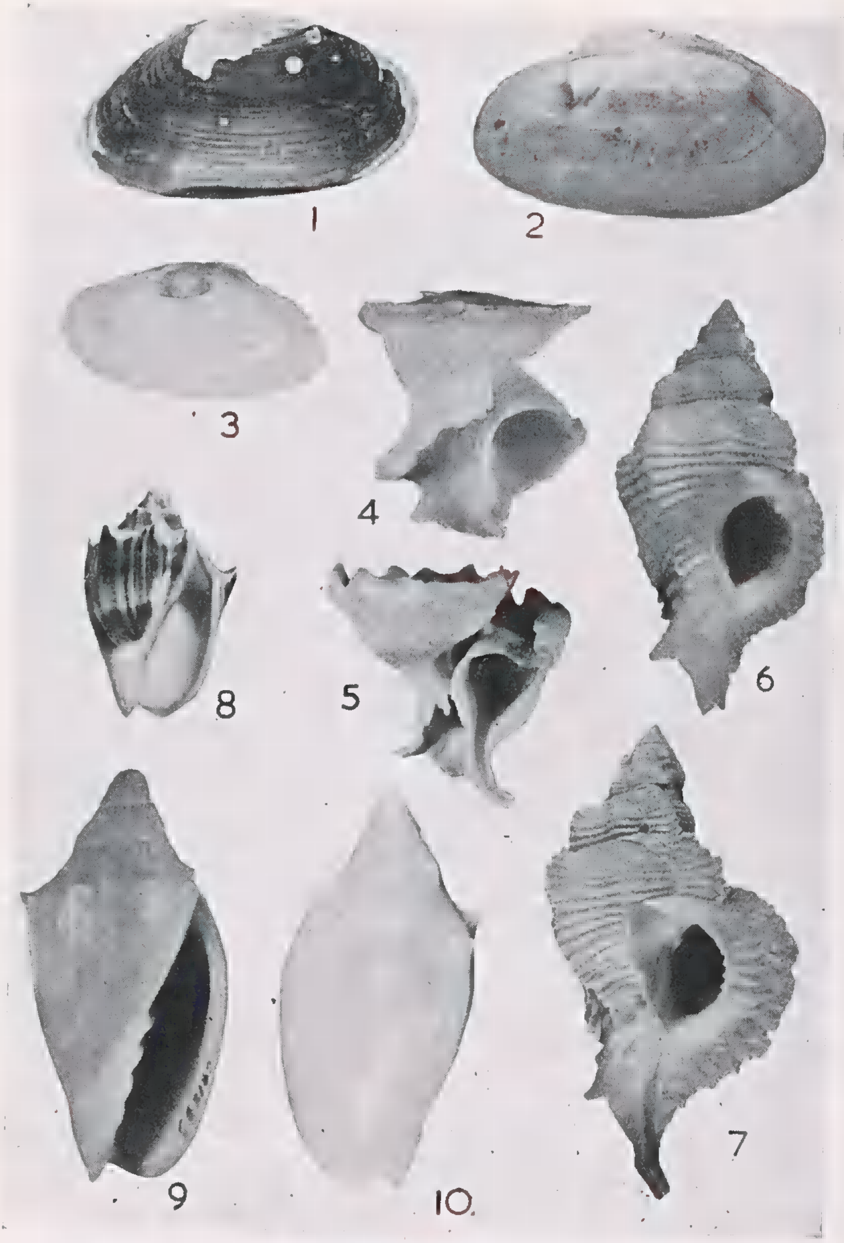


PLATE 4.

Figs. 1, 2: *Psammotaea crassula* (Deshayes). Clarence River, N.S.W. Aust. Mus., C. 63355. Mag. X1

Fig. 3: *Psammotaea crassula* (Deshayes). Aboriginal campsite, Clarence River, N.S.W. Aust. Mus., C 63356. Mag. X1

NEW SPECIES AND NEW RECORDS OF MARINE MOLLUSCA FROM AUSTRALIA

By DONALD F. McMICHAEL, Ph.D.*

A number of interesting specimens belonging to several groups of marine molluscs have come to hand at the Australian Museum during recent months, some representing new range records, others new species, and for one of the latter, a new genus is necessary.

CLASS BIVALVIA (= PELECYPODA)

FAMILY GARIIDAE

Psammotaea crassula (Deshayes)
(Pl. 4, figs. 1-3.)

Capsa (Capsella) crassula Deshayes, 1855, Proc. Zool. Soc. London, 1854, p. 349. Reeve, 1857, Conch. Icon., 10, *Capsella*, pl. 2, sp. & fig. 8.

Remarks: While excavating an aboriginal campsite in the Clarence River district near Grafton, N.S.W., Dr. M. L. Ryder of New England University, Armidale, found numerous buried animal remains which were submitted to the Australian Museum for identification. Among them were some mollusca, mostly common species of bivalves from New South Wales still living in the vicinity, but several specimens of a bivalve attracted attention. They were obviously members of the family Gariidae (alternately known as Sanguinolariidae or Psammobiidae) but could not be assigned to any recorded Australian species. However comparison with specimens in the collection revealed two shells from the Clarence River, collected by Brazier and obviously living or recently dead specimens when found, which have been overlooked by later workers on the Museum collection.

Brazier had identified the shells as *Capsella crassula* Deshayes, a species described from the Philippines and figured by Reeve; comparison with the figure shows that the Clarence River shells are very similar and they agree well with the description. No dimensions are given by either Deshayes or Reeve, but assuming that Reeve's figure is natural size, the Brazier shells are a little larger, while the campsite shells are about the same size as the type. A somewhat similar species was described by Bertin (1880) as *Hiatula (Psammotaea) complanata* (p. 100, pl. 5, fig. 3) from unknown locality. This shell is somewhat more slender than the Clarence River specimens, but otherwise agrees closely.

*The Australian Museum, Sydney, N.S.W.

PLATE 4—Continued.

Fig. 4: *Latiaxis mawae* (Griffith & Pidgeon). 118 fm., off Cape Moreton, Queensland. Aust. Mus. C. 63357. Mag. X1

Fig. 5: *Latiaxis mawae* (Griffith & Pidgeon). Hong Kong. Aust. Mus. C. 38738. Mag. X1

Fig. 6: *Pterynotus patagiatus* (Hedley). Keppel Bay, Queensland. Aust. Mus. C. 63358. Mag. X1

Fig. 7: *Pterynotus patagiatus* (Hedley). Dredged between Bowen and Townsville, Queensland. T. Garrard Collection. Mag. X1

Fig. 8: *Aulicina vespertilio* (Linne). Bathurst Island, Northern Territory. Aust. Mus. C. 63359. Mag. X½

Figs. 9, 10: *Pseudocymbiola provocationis* McMichael. Holotype. Trawled off Ulladulla, N.S.W. Aust. Mus. C. 63182. Mag. X1

The generic name to be used for the species is somewhat doubtful. *Capsella* Deshayes was introduced for a number of similar species, but is preoccupied. Most authors have used *Psammotaea* Lamarck, introduced for eight species in the Histoire Naturelle, without designated type species. Dall (1900) reviewing the taxonomy of this group regarded Bowdich (1822) as the first type designator by virtue of the citation of *Psammotaea serotina* Lamarck as example; this would make *Psammotaea* available for the present species and is the accepted usage. However it seems doubtful whether such citations qualify as valid type designations today. The next available is that of Children (1823) who selected quite a different species (*Psammotaea donacina* Lamarck) as type. I am not convinced that the latter is congeneric with *crassula* Deshayes, but for the time being the present species can be left in *Psammotaea*.

CLASS GASTROPODA

FAMILY CORALLIOPHILIDAE

Latiaxis mawae (Griffith & Pidgeon)*

(Pl. 4, figs. 4, 5.)

Pyrula mawae Griffith & Pidgeon, 1834, Cuvier's Animal Kingdom, 12, pl. 25, figs 3, 4, p. 599.

Latiaxis mawae. Swainson, 1840, Treatise on Malacology, pp. 82, 306. Kira, 1955, Coloured Illustrations of the Shells of Japan, pl. 25, fig. 26.

Remarks: The occurrence of this well known species on the eastern Australian coast is astounding, in view of the restricted distribution which the species was previously thought to enjoy. A single, dead and somewhat worn specimen was received from Mr. W. Lillistone of Brisbane, who kindly presented it to the Australian Museum. It was dredged in 110 fathoms, off Cape Moreton, and probably was collected by m.v. "Challenge". The shell compares well with Japanese specimens of *L. mawae* in the Australian Museum collection, though the photograph on plate 4, fig. 4 will show that it differs somewhat in the descent of the whorls, when compared with a typical Japanese shell (pl. 4, fig. 5), though there is some variation in this feature among Japanese specimens. The angle of protrusion of the encircling flat spines at the shoulder of the whorl is different in the Australian specimen, being more-or-less horizontal (if the shell be held with the axis vertical) whereas the Japanese shells nearly always have the spines curling upwards. However, these differences are not sufficient to warrant specific separation of the Australian shell in view of its otherwise close resemblance to *Latiaxis mawae*. (It should be pointed out that the differences betwen the Japanese coralliophilid *Tolema lischkeana* (Dunker) and the Australian *Tolema autstralis* Laseron, are much the same as those indicated above, especially the angle of protrusion of the shoulder spines from the body whorl.)

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*Two live specimens of this species were dredged in Western Australian waters by the Hawaiian-West Australian Expedition in June, 1960.

The generic allocation of species of the family Coralliophilidae is not satisfactory at present and much revision is necessary. However the present species, being the type species of *Latiaxis* is correctly located therein.

FAMILY MURICIDAE

Pterynotus patagiatus (Hedley)

(Pl. 4, figs. 6, 7.)

Murex patagiatus Hedley, 1912, Rec. Aust. Mus., 8, p. 151, pl. 43, fig. 36.

Remarks: This lovely muricid has been found in numbers during recent years by trawling and dredging at various localities in Queensland. Its determination proved difficult, as it resembled a miniature species of the "*pinnatus*" group but did not match any known Queensland or tropical species. However, comparison with the species described by Hedley from New South Wales as *Murex patagiatus,* revealed a very close affinity; the southern shell is almost completely lacking in the foliated expansion of the varices, characteristic of the northern specimens, but otherwise the two forms are almost identical. When naming *patagiatus,* Hedley referred to a couple of specimens, rather beachworn, from Ballina, north New South Wales, but selected as holotype a shell from Sydney Harbour, dredged by Brazier. Study of the type series in the Australian Museum shows that the two beachworn shells are not the same species as the holotype, but are in fact worn specimens of *Torvamurex denudatus.* A few specimens of *patagiatus* from Queensland (Lindeman Island, North West and Masthead Islands) were located in the Australian Museum collection, but these were all dredged and imperfect specimens. A pair of clean, live shells were sent by Mr. and Mrs. R. Brown, of Yeppoon, Queensland, to Mr. T. Garrard, who passed them on to the Museum for identification. They differ slightly from the holotype in having a somewhat more elongate shell, with the foliate varices very well developed and with a longer siphonal canal. However the type of *M. patagiatus* is a dead shell, and while it lacks the well developed foliation of the varices, these could have been worn away. It is however a more squat shell, but without additional material from New South Wales it is not possible to separate the two forms. Conceivably the Queensland shells could represent a northern subspecies, but for the time being they are referred to *patagiatus.* The Keppel Bay shells are pinkish white in colour, but specimens from further North, dredged between Bowen and Townsville are a bright orange-pink between the varices.

The generic name to be used for the species is apparently *Pterynotus* Swainson (type species *pinnatus* Swainson) and *patagiatus* Hedley has many affinities with the type. Generic divisions in the Muricidae are far from well established however and the name is used with some reservation as there seems to be almost continuous variation in this family from genus to genus. Hedley compared his species with *Murex denudatus,* but the comparison was probably the result of his having confused two worn specimens of that species with his new species. In fact *Murex denudatus* is in no way similar to the present form.

FAMILY VOLUTIDAE

Aulicina vespertilio (Linne)

(Pl. 4, fig. 8.)

Voluta vespertilio Linne, 1758, Syst. Nat., Ed. 10, p. 733, Vermes Testacea sp. 371. Reeve, 1849, Conch. Icon., 6, *Voluta,* pl. 5, sp. & fig. 11.

Remarks: The range of this species has till now been known to extend from the Philippines through the eastern Islands of Indonesia to the north coast of New Guinea, but to my knowledge it has never been recorded from the southern coast of New Guinea and certainly not from Australia. Specimens are now to hand from Bathurst Island, off the north-west tip of Arnhem Land, collected by Mr. C. F. Kurtze of Portland, Victoria, and presented to this Museum by Mrs. D. I. Hartley. At first sight, the shells appear to differ somewhat from normal populations of the species, but comparison with the figures in Reeve show that they agree closely in form with shells figured by Reeve as "typical" *vespertilio,* differing only in coloration, which in the Bathurst Island shells is uniformly streaked longitudinally with dark brown on a cream shell.

PSEUDOCYMBIOLA gen. nov.

Type Species: *Pseudocymbiola provocationis sp. nov.*

Remarks: Among some shells collected by m.v. "Challenge" off the south coast of New South Wales were a couple of volutes which at first sight, resembled discoloured specimens of some form of *Cymbiolacca.* However closer examination revealed that they had nothing whatever to do with *Cymbiolacca,* differing in the structure of the protoconch. One shell was obtained from the master of "Challenge", Mr. Evans Paddon, and the other from Mr. T. Garrard who kindly handed their shells to me for description. The relationship of these two shells is seen at once when a number of Tertiary species of volutes from southern Australia are studied. These species, including the forms described as *Voluta weldi* Tenison-Woods, *Voluta strophodon* McCoy and *Voluta strophodon brevispira* Pritchard (but not necessarily all the species listed by Cotton (1949) as *Cymbiola*) show a close resemblance to the present species in general form and more particularly in the protoconch which is comparatively small, hemispherical, white, quite smooth, of about 2½ whorls and merges without a break into the juvenile whorls.

In body form the shells fall into the general volutid pattern of moderately long spire, spinose shouldered whorls, several strong columellar plaits and a well developed basal fasciole. The generic name adopted above indicates that in some general features these shells recall members of the genus *Cymbiola s.l.* but the latter group has a flattened, ribbed protoconch and the shells are generally much larger species.

It would appear that the new, living species to be described below, is the present-day derivative of the Tertiary *strophodon* group, which probably represents an old Australian element in the Tertiary fauna, whereas the genus *Cymbiola* (and *Aulica* which is often grouped with it) probably is part of the Tethyan element in our fauna, from which most of the present Indo-Pacific tropical species derive.

Pseudocymbiola provocationis sp. nov.

(Pl. 4, figs. 9, 10.)

Description: Shell of medium size, maximum length 45 mm., maximum diameter 22 mm., spire elevated, body whorl large, aperture 32 mm. in length. Protoconch comparatively large, rounded, creamish-white, of 2½ whorls, with faint, spiral striations, merging imperceptibly into the adult whorls which number 3½. Spire slightly nodulose, the nodules increasing in size on the penultimate whorl and fully developed on the body whorl, where they form a crown at the shoulder of the whorl; nodules sharply pointed, outstanding, numbering from five to seven on the body whorl. Colour of shell orange-fawn, with faintly orange patches clouding the spire and body whorl and a few scattered dots of orange brown, mostly obscure, with a series of short, vertical, orange-brown lines below the suture, spaced about one mm. apart and scarcely one mm. in length. Aperture white in colour, with a thin white opaque callus across the inner lip and continuing onto the basal fasciole. Four strong columellar plications.

Types: The holotype is the larger of the two specimens available, and was trawled off Ulladulla, N.S.W. It is in the Australian Museum, Registered No. C. 63182. A paratype from off Port Kembla, N.S.W., has been presented to the National Museum of Victoria, Melbourne.

Paramoria weaveri sp. nov.

(Pl. 5, top figs.)

Remarks: The following new species was collected last year by the Hawaiian-Western Australian expedition which carried out dredging operations along the southern half of the Western Australian coast during May and June, 1960, in the yacht "Davina". It is proposed to report fully on the collections of Volutidae made by the expedition at a later date, but the present species is of particular interest and I have been asked to expedite its description. The shell was tentatively identified as *Nannamoria guntheri* (Smith) but comparison with specimens in the Australian Museum and study of the original description and figure show that it is quite a different species. The new form is small, but apparently adult and resembles *guntheri* in shape, though the spire is more depressed and the whorls more shouldered. The colour pattern is of a generally similar type, but the arrangement of the chestnut lines is distinctive. For these reasons, it is described as a new species of the genus *Paramoria* McMichael, recently proposed by me for *guntheri* Smith, (*Journ. Malacol. Soc. Australia*, 4, p. 12).

Description: Shell small, 27 mm. maximum length, 14.5 mm. maximum diameter, aperture 24 mm. in length. Body whorl large, spire short, whorls shouldered and sharply nodulose, aperture gaping, inner lip with four columellar plaits. Protoconch comparatively large, of 3½ whorls, quite smooth, pale fawn in colour with the exception of a narrow band of white encircling the protoconch whorls just below the suture. Adult whorls 2½, pinkish cream, longitudinally striped with fine chestnut-brown lines; most of the lines not continuous, but breaking off abruptly and replaced by lines which run parallel to them for short distances; a few lines continuous from top to bottom however. Lines clumped together at intervals and thickened, giving an impression of a series of blotches of colour, occurring in two bands encircling the shell, one about 5 mm. below shoulder, the

other some 10 mm. below that. Whorls shouldered, becoming nodulose, the nodules sharply pointed, but not produced into spines, numbering 9 or 10 on the body whorl.

Animal with a broadly expanding foot, cream to yellowish in colour, brilliantly patterned with a lattice of orange lines and reticulations.

—Block by courtesy of the Royal Zoological Society of New South Wales.

PLATE 5.

Top three figures: *Paramoria weaveri* McMichael. Holotype. Bishop Museum No. 213874.

Bottom two figures: *Paramoria guntheri* (Smith). Encounter Bay, South Australia. Australian Museum No. C. 62111.

Proboscis banded with orange; tentacles and lateral lobes of head crossed by fine brown lines. In alcohol, all colours faded, except the brown lines on the tentacles and head lobes. Siphon short, with comparatively long appendages, which are expanded distally. Tentacles long, with broad lobes beside them, the eyes prominent at the bases of the tentacles. Fleshy hood above the proboscis white, its margin fimbriated. Radula uniserial, with about 205 Y-shaped teeth, each aproximately 0.158 mm. by 0.105 mm., the arms of the Y long and slender, the cusps short, slender and sharply tapering.

Type Locality: Zeewyck Channel, Abrolhos Islands, dredged in 80 fathoms, 12th May, 1960.

Types: The unique holotype, including the dissected animal and radula slide, is in the Bernice P. Bishop Museum, Honolulu, Catalogue No. 213874.

Additional Remarks: The species is named for Mr. Clifton Weaver, President of the Hawaiian Malacological Society who collected the specimen and made the colour notes on the living animal, details of which have been given above.

The shell is in many ways a miniature of *P. guntheri,* (Pl. 5, bottom two figures) but it differs in being markedly smaller, in the more pronounced undulation of the lines and in details of the shape of the shell. These differences are clearly illustrated in the accompanying figures. The presence of a radula in the holotype of *P. weaveri* enables the affinity of the genus *Paramoria* to be determined for the first time. The Y-shaped radular teeth place it in the subfamily Scaphellinae, and it must stand next to *Cymbiolista* Iredale and *Amoria* Gray.

REFERENCES.

BERTIN, V., 1880, Nouv. Arch. Mus. Hist. Nat. (10), 3, pp. 57-129.

BOWDICH, T. E., 1822, Elements of Conchology. 8vo. Paris.

CHILDREN, J. G., 1823, Quart. J. Sci., 14, p. 304.

COTTON, B. C., 1949, Rec. South Aust. Mus., 9, pp. 181-196.

DALL, W. H., 1900, Trans. Wagner Free Inst. Sci., 3, p. 971.

NOTES AND RECORDS

Another Poisonous Octopus Bite.

Some years ago I recorded* a poisonous bite by the common Ringed Octopus *(Hapalochlaena maculosa)* which occurred in the Wollongong District of New South Wales. On that occasion, there was no *direct* evidence that the bite had been by the Octopus, though the circumstantial evidence was very strong. Confirmation of the poisonous nature of the bite of this small species has now been received, from Mrs. L. Masters, of Swansea, New South Wales (at the entrance to Lake Macquarie). Mrs. Masters reports that a young boy was bitten on the hand by one of these Octopus and shortly afterwards complained that he was not feeling well and went home. He drank a glass of water, but immediately complained to his parents that he was sick. He lost all co-ordination of his limbs, his speech became thick and he kept saying that he could not breathe. His skin became very cold and clammy and vomiting set in. At intervals there was spasmodic jerking of the limbs. These symptoms persisted for some hours. Gradually, after about eight hours, his speech returned to normal, then his arms recovered, but it was a couple of days before he could walk without assistance. These symptoms are almost exactly the same as those reported by the man bitten at Wollongong, and they emphasise the extreme virulence of the neurotoxin produced by this species. Extreme care should therefore be exercised when handling this Octopus, which may well be capable of inflicting a fatal bite on a susceptible individual.

Donald F. McMichael.

*McMichael, D. F., 1957, Proc. Roy. Zool. Soc. N.S.W., 1955-56, p. 110.

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MONOGRAPHS OF THE GENERA *PAPUSTYLA, FORCARTIA* and *MELIOBBA* (PAPUININAE: CAMAENIDAE).

By WILLIAM J. CLENCH, Ph.D.* and RUTH D. TURNER, Ph.D.*

Plates 1-3,
Figures 1-9.

This present study is one of several planned to cover the various genera in the subfamily Papuininae. During the past several years much new alcoholic material has been made available to us so that anatomical data are now available for several species and species groups heretofore unknown.

The subfamily Papuininae in the family Camaenidae ranges from the Moluccas eastward through New Guinea, the Louisiades, Admiralty, Bismarck and Solomon Archipelagoes, and Queensland, Australia. Unlike many of the highly coloured tree snails such as *Liguus, Polymita, Achatinella* and *Partula,* they are found in a rather inaccessible region of the globe, much of it still imperfectly known, a little of it still wholly unexplored. *Papuina* †, besides possessing many beautiful colour variations, also has many structural differences in the shell contour. The shells may be lenticular, globose, or they may have extended spires which are somewhat bulimoid in shape. *Papuina* and its related genera probably have a very long evolutionary history. The subfamily is widely distributed, but insular isolation of the various elements has allowed remarkable differentiation to take place so that most species are rather sharply defined. This is in direct contrast to *Liguus, Polymita, Achatinella* and *Partula* where only a limited few species and species groups are really sharply defined, the multitude of species being only slight modifications of a general pattern, either in colour or in shape.

Surprisingly enough, few professional malacologists have ever collected "*Papuina*". Most of the early described species were obtained by traders, explorers or collectors of other animal groups and the collecting of *Papuina* was purely incidental to other interests. Locality data were mixed, probably guessed at in many cases, and species were assigned to islands not at all their original localities. Also, in the early days, the terms Solomon, Admiralty and Bismarck Islands were loosely interchangeable or, at least, not clearly defined. Consequently many of the early records have little meaning when considered in the light of our present and rather sharp differentiation of these archipelagoes.

Difficulties in understanding many species still exist. Many of the species were inadequately described, often without figures, and others with incorrect locality data. Confusion about certain species will naturally exist for many years to come, at least until the type specimens, if they are still extant, can be examined.

In certain places *Papuina* must be extraordinarily abundant, at least if we may judge by the remarkable series obtained by Mr. W. F. Coultas in the Bismarck and Admiralty Islands during the Whitney South Sea Expedition. The same is true of Dr. W. M. Mann's collecting in the Solomons in 1918. Though, in general, his series of the various species collected were small, as his interest was in another field, he told us that

* Museum of Comparative Zoology at Harvard College, Massachusetts, U.S.A.

† In the introduction of this paper we are using "*Papuina*" in the broad sense, as the genus has been generally understood during the past two generations.

Papuina boivini Petit were everywhere on the trunks of the palm trees at Fulakora, Isabel Is., Solomon Islands.

Iredale [1] gave family status to the genus *Papuina* v. Martens and the few genera originally associated with it. No differential characters are given, either based on the morphology of the shell or on any of the soft parts, to separate this group from the family Camaenidae. In this and in a subsequent publication [2] a large number of genera are proposed, apparently chosen at random, with type species selections for fixation. Few or no relationships are given for these various genera, and the descriptive diagnoses for the genera concerned are remarkable for their brevity. In other words, the entire burden of proving the taxonomic value of these genera will rest upon subsequent workers. This will be difficult. In the first place, specimens of Iredale's many new species will be needed and these should be preserved in alcohol, for anatomical work is needed in order to have a proper understanding of the interrelationships of these "genera".

We do not intend to minimize the fact that *Papuina* in the broad sense is a complex assemblage of generic elements and should, when the necessary data are at hand, be split into as many genera as the data warrant. We do hold, however, that to create arbitrarily a host of new names without giving the necessary supporting facts is both poor taxonomy and unsound biology.

Pilsbry, in 1894, when reviewing the genus *Papuina* as it was then understood, stated "The great variation observed in the genitalia and teeth of the species examined show that here lies a wide field for future cultivation. These features are, no doubt, characteristic of minor groups in the genus and their investigation will lead to valuable results in the classification of the group and secondarily may be of use in the study of geographical distribution and migration." As stated above, Iredale without further anatomical work, raised the genus to the rank of family, the Papuinidae, and gave generic names to most of Pilsbry's "species groups". There is no question that the ultimate answer to this complex group of species is somewhere between these two extremes.

In the present study, which is only a small part of the planned monographic study of the subfamily Papuininae, dissections have been made of six species, five of which are figured. In addition, anatomical studies have been made of eleven other species which are not discussed in this report. The striking differences in the reproductive anatomy of various species indicate that they have been long established. When resemblances do occur they lend strength to their generic grouping. Variations in the anatomy of the reproductive system within the species is often the result of the particular phase of the breeding cycle in which the animal happened to be at the time of capture. Differences in the relative proportions, of the various organs seem to be of little value and should not be used unless sufficient specimens can be dissected to show that they are constant throughout the year. As shown in the two illustrations of the reproductive anatomy of *P. hindei* (Figs. 4, 5) the spermathecal duct doubles in length when the uterus is full of well developed eggs because the duct is attached by mesenteries to the uterus and is interwoven among the eggs and consequently stretches as the

1 Australian Zoologist, *9* : 91, Nov. 1938.
2 Australian Zoologist, *10* : 74-85, Dec. 1941.

eggs develop. The penis in such a specimen is proportionately very much smaller and the exhausted albumen gland greatly reduced in size. The tremendous size of the penial organs of *P. pulcherrima* as shown in Fig. 2 (2) may indicate that the animal was taken during, just before or after copulation, though the five specimens dissected were all the same.

The structure of the walls of the penis, the shape of the penis papilla, and the presence or absence of the epiphallus and flagellum all appear to be good characters for taxonomic purposes. The presence or absence of an organ is a far more satisfactory character for specific work than any variation in size.

Very little is known concerning the breeding period or mating habits of the Papuininae, although they are probably similar to other members of the Camaenidae. Through the kindness of Donald F. McMichael we had a series of preserved specimens of *P. hindei* for study. In one of these the uterus was filled with eggs, the largest of which is 5 mm. in length. The eggs are white and when fully developed have a rather thick, granular, calcareous shell.

A great deal more work must be done before generalizations can be made concerning the relationships of the shell, the anatomy, the radula and the jaws in classifying this large and diverse subfamily. However, to date it would appear that there is a strong correlation as indicated in the following chart.

CHART COMPARING SOME OF THE MAJOR CHARACTERS OF SPECIES OF *MELIOBBA* and *PAPUSTYLA*.

	Meliobba			*Papustyla*			
	popondetta	*mcmichaeli*	*helenae*	*pulcherrima*	*hindei*	*xanthochila*	*chancei**
SHELL							
1) depressed globose	X	X	X				
2) attenuate				X	X	X	X
RADULA							
1) straight rows	X	X	X				
2) V-shaped rows				X	X	X	X
JAWS							
1) smooth	X	X					
2) ribbed			X	X	X	X	?
EPIPHALLUS							
1) stout and recurved	X	X	X				
2) thin and not recurved				X	X	?	X
FLAGELLUM							
1) present	X	X					
2) absent			X	X	X	?	X
SPERMATHECAL DUCT							
1) short	X	X	X				
2) long				X	X	X	X

* Based on work of I. Rensch.

FIGURE 1.

From the foregoing chart it would appear that the presence or absence of flagellum on the epiphallus and the ribbing of the jaws are probably not dependable as characters for generic diagnosis. It must be remembered that the anatomy of very few species is known and that changes in generic definitions may well have to be made before the series of monographs is finished.

Pilsbry (1894) divides the radula of *Papuina s.l.* into two main groups: (1) those with the transverse rows of teeth straight and with the teeth varying in shape toward the marginals; (2) those with the transverse rows of teeth V-shaped and the teeth all of the same general form. We agree with Pilsbry on the arrangement of the teeth, but have found that in *P. hindei* and *P. pulcherrima* there is considerable change in the shape of the teeth even though they are arranged in V-shaped rows, while in *xanthochila* the teeth are similar. The arrangement of the teeth in straight or V-shaped rows is probably basic and will indicate generic relationships, while the shape of the marginal teeth is a secondary variation of value on the specific level only.

We are greatly in need of preserved material and would appreciate hearing from anyone who could help us secure it.

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ABBREVIATIONS.

AI—Auckland Institute and Museum, Auckland, New Zealand.

AM—Australian Museum, Sydney, Australia.

AMNH— American Museum of Natural History, New York, N.Y.

BM(NH)—British Museum (Natural History), London, England.

BPBM—B. P. Bishop Museum, Honolulu, Hawaii.

CM—Chicago Natural History Museum, Chicago, Illinois.

CMP—Carnegie Museum, Pittsburgh, Pennsylvania.

MCZ—Museum of Comparative Zoology, Cambridge, Mass.

MM—Manchester Museum, Manchester, England.

NMV—National Museum of Victoria, Melbourne, Australia.

UM—Museum of Zoology, University of Michigan, Ann Arbor, Mich.

USNM—United States National Museum, Washington, D.C.

ZM—Zoologisch Museum, Amsterdam, Holland.

Genus *PAPUSTYLA* Pilsbry

Papustyla Pilsbry 1893, Manual of Conchology (2) 8: 243; Rensch 1934, Archiv für Naturgeschichte (n.s.) 3: 460.

Type species: *Cochlostyla hindei* Cox, subsequent designation, Rensch 1934, p. 36.

Shell generally attenuate, smooth and glossy. Lip not descending, usually broadly reflected and lacking the papuinoid notch. Imperforate or perforate. Colour generally a uniform white, brown or green with or without spiral bands. Lip white, brown or yellow.

The genus *Papustyla* is known only from Manus Island in the Admiralty Archipelago, New Britain Island in the Bismarcks and the two northern most islands, Bougainville and Choiseul, in the Solomons.

It is possible that a few of the small but attenuated species from the Solomon Islands belong to *Papustyla*. Their generic position will remain unknown until anatomical material is available for study.

Papustyla pulcherrima (I. Rensch)
Pl. 1, fig. 1; Figs. 2, 3(4), 6(1).

Papuina pulcherrima I. Rensch 1931, Zoologischer Anzeiger 95: 187, fig. 1 (Manus Island, Admiralty Islands); 1934, Archiv für Naturgeschichte (n.s.) 3: 468, text fig. 10.

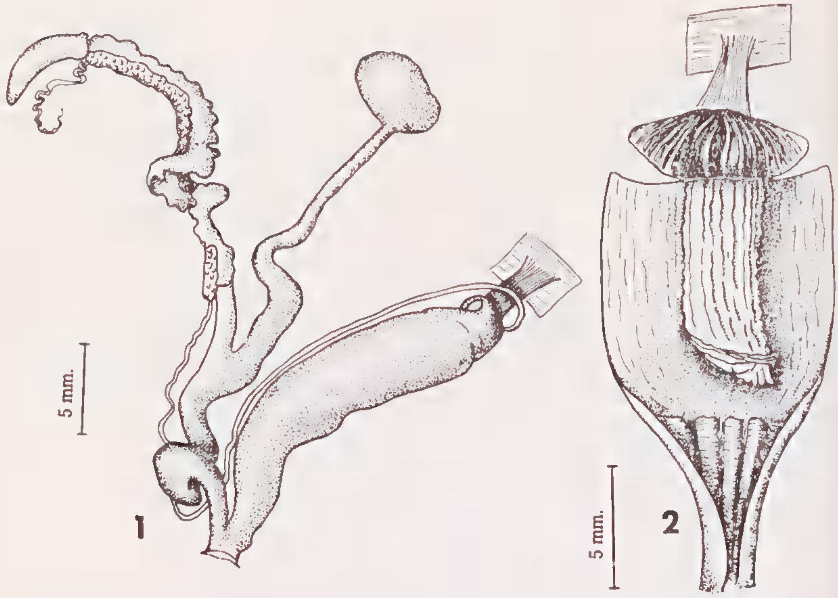

Fig. 2
Anatomy of the reproductive system of *Papustyla pulcherrima* (Rensch).
Fig. 1, complete system. Fig. 2, dissected penis. See Fig. 8 for labelling.

Description: Shell extended, conic, rather light in structure but strong, reaching about 44 mm. in length, imperforate and smooth. Whorls six, slightly convex, and the last whorl showing a slight keel or angle just below the whorl periphery. Colour: first two and a half whorls a grayish white infused with reddish brown, particularly on the lower half of each whorl. Remaining whorls an intense pea-green with a canary-yellow band just below the periphery. On the earlier whorls this yellow band shows up along the suture. Lip and columella china-white. Spire extended, produced at an angle of about 55°. Aperture subquadrate. Parietal lip consisting of only a very thin glaze. Palatal lip reflected, slightly thickened and obtusely pointed at the peripheral area. In profile, the palatal lip is very slightly sigmoid in outline and produced at an angle of about 55° from the base. Papuinoid notch hardly indicated. Columella nearly straight, somewhat thickened below and very slightly twisted. Suture well defined and but slightly indented. Sculpture consisting of exceedingly fine growth lines, the entire shell appearing very smooth and glossy. Nuclear whorls two and a half to three, smooth and somewhat obtuse.

In the five specimens of *Papustyla pulcherrima* dissected, the spermathecal duct was very long and closely attached to the uterus by mesenteries, the globular spermatheca lying near the base of the albumen gland. The vas deferens is extremely long, winding around the oviduct, the vagina and the penis. The penis is very large, as shown in Fig. 2. It is thin-walled except near the opening into the atrium where there are

heavy muscular ridges. The penis papilla is large, cylindrical and heavily ridged. The epiphallus is thin and greatly reduced, possibly a result of the stage of the breeding cycle when it was collected. All specimens dissected were from a single lot and showed remarkable uniformity in the structure of the organs.

Length	Width	
43.0 mm.	28.5 mm.	Drabui Village, Manus Island
44.0 mm.	30.5 mm.	Drabui Village, Manus Island
40.6 mm.	26.8 mm.	Drabui Village, Manus Island
35.2 mm.	26.0 mm.	Drabui Village, Manus Island

Types: The holotype of *Papuina pulcherrima* Rensch is in the Berlin Museum; the type locality is Manus Island, Admiralty Islands.

Remarks: This is an exceedingly characteristic species. Its intense green coloration makes it almost unique among all known species of land molluscs. It is probably equalled in coloration only by *Helicina viridis* from Hispaniola in the West Indies. This coloration is invested entirely in the periostracum, with a yellow layer underlying the green. Specimens lose the green periostracum very soon after death of the mollusc, leaving the shells almost a pure, dull white, the green periostracum remaining only on the parietal wall where it has been glazed over and thus protected.

See *Remarks* under *novaepommeraniae* for comparisons.

Range: Known only from Manus Island, Admiralty Archipelago.

Specimens examined: ADMIRALTY ARCHIPELAGO MANUS ISLAND: Drabui Village; Petaiya; Tavi Village; Malai Village (AMNH; MCZ); Pundrau (BPBM); Tungon (ANSP; Berlin Museum); Lorengau (MCZ).

Papustyla hindei (Cox)

Pl. 1, figs. 9-10, Pl. 3, fig. 8; Figs. 3(5), 4, 5, 6(2).

Cochlostyla hindei Cox 1888, Proc. Linnean Soc. New South Wales (2) 2: 1063 (New Ireland).

Helix (*Geostrochus* [sic]) *heimburgi* Brancsik 1891, Jahresheft Naturwissenschaftlichen Vereines Trencsener Comitates 13: 80, pl. 7, fig. 2a-b (Matupit, Nov. Brittania).

Cochlostyla ? finschi v. Martens 1894, Conchologische Mittheilungen 3: 12, pl. 46, fig. 5-6 (Polynesia or New Guinea); v. Martens 1897, Archiv für Naturgeschichte 63: 43, pl. 8, fig. 5-6 (New Britain).

Papuina (*Papustyla*) *hindei* Cox. Thiele 1928, Zoologische Jahrbücher 55: 140, pl. 5, fig. 31.

Papuina infracolorata I. & B. Rensch, 1929, Zoologischer Anzeiger 80: 77. (Weiten Bucht [Wide Bay] south coast of New Britain).

Description: Shell extended, conic, light in structure but strong, reaching 49 mm. (two inches) in height, imperforate and smooth. Whorls seven and moderately convex. Colour, nuclear whorls a rather dark brown, remaining whorls a shining light brown with a fine dark brown sub-sutural line, lip a very dark brownish black, interior of aperture whitish. Occasional specimens have light straw-yellow nuclear whorls with the remainder of the shell a uniform dark chocolate-brown. Columella white,

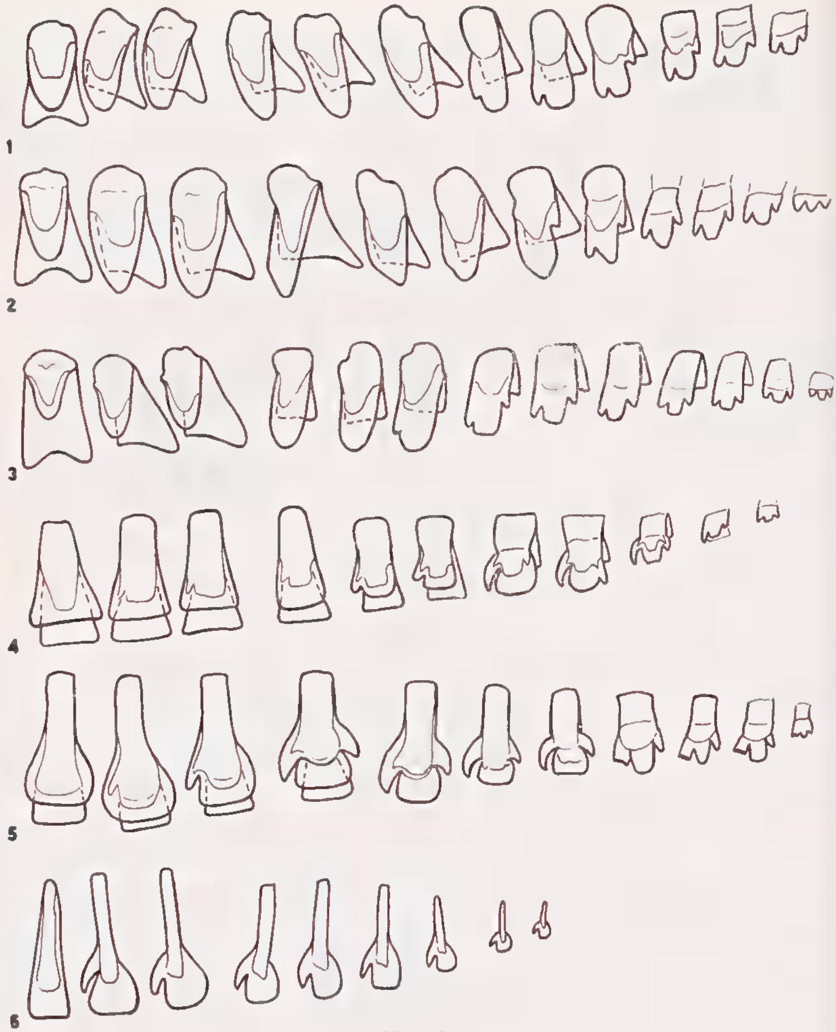

Fig. 3
Radulae

Fig. 1, *Meliobba helenae* Clench and Turner.
Fig. 2, *Meliobba mcmichaeli* Clench and Turner.
Fig. 3, *Meliobba popondetta* Clench and Turner
Fig. 4, *Papustyla pulcherrima* (Rensch).
Fig. 5, *Papustyla hindei* (Cox).
Fig. 6, *Papustyla xanthochila* (Pfeiffer).

but surrounded by a rather wide band of blackish brown. Spire extended and produced at an angle of about 48°. Aperture sub-ovate. Parietal lip consisting of only a very thin glaze. Palatal lip expanded and somewhat thickened. In profile, very slightly sigmoid in outline and produced at an angle of 55° from the base. Columella nearly straight, not materially thickened and apparently not twisted. Suture well defined and slightly

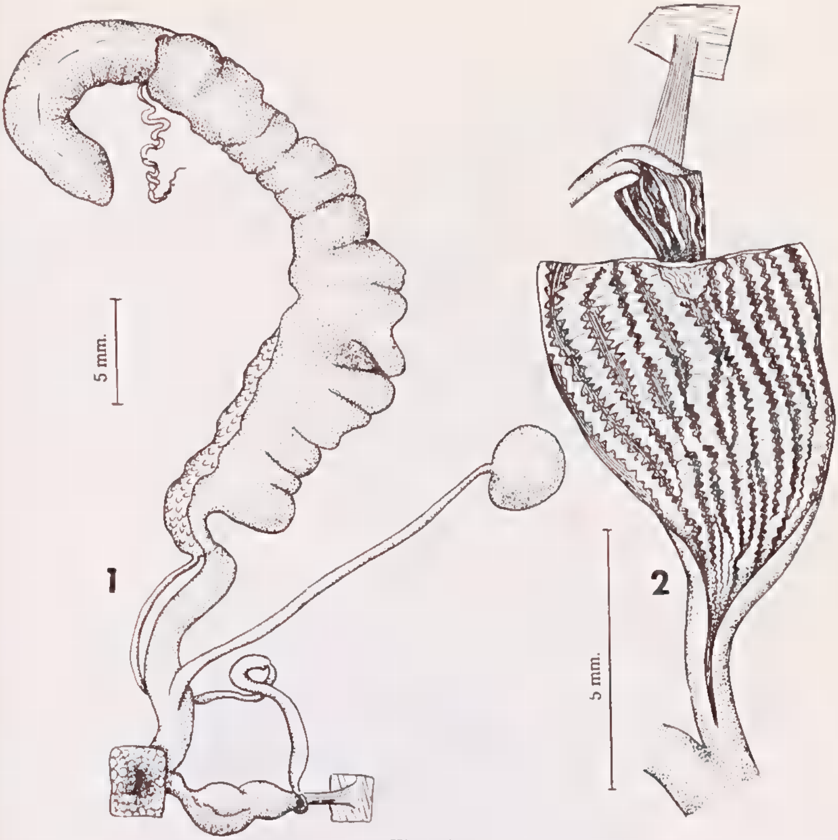

Fig. 4

Anatomy of the reproductive system of *Papustyla hindei* (Cox). Fig. 1, complete system. Fig. 2, dissected penis. See Fig. 8 for labelling.

indented. Sculpture consisting only of exceedingly fine growth lines, the shell appearing very smooth. Nuclear whorls two and a half to three, smooth and obtuse.

The anatomy of *Papustyla hindei* is similar to that of *P. pulcherrima*, though the penis of *hindei* is very much smaller and has a long, thin epiphallus with the vas deferens entering at the end. The wall of the penis has numerous high, irregular flutes and the penis papilla is very small as shown in Fig. 4. Whether these striking differences between *pulcherrima* and *hindei* are a reflection of the breeding condition of the animals it is impossible to say. In one specimen of *hindei* the uterus was filled with developing eggs, those near the vagina being fully developed and having a granular, calcareous shell. The differences in the relative proportions of the various organs in a specimen carrying eggs and one without are shown in Figs. 4, 5. The radula and jaw of *hindei* is similar to that of *pulcherrima* as shown on Fig. 3.

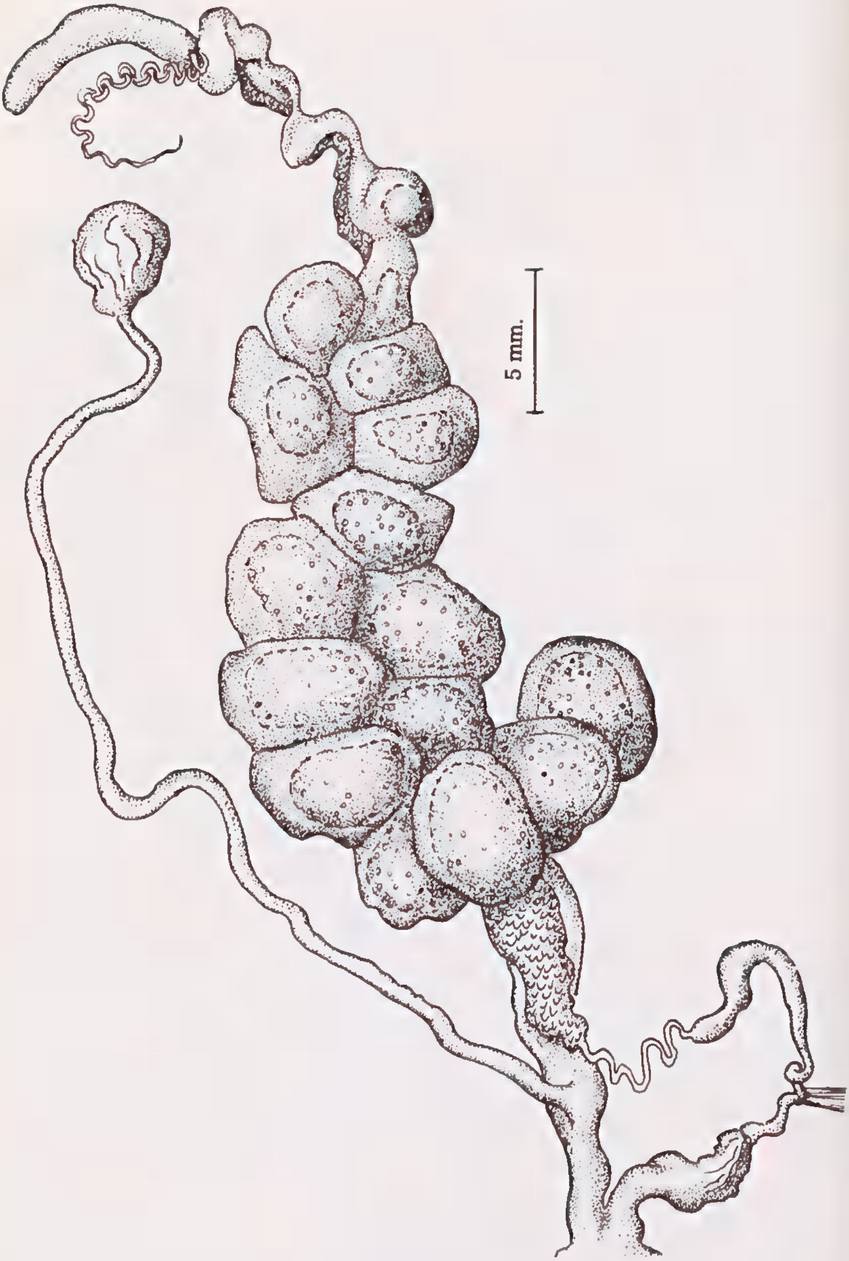

Fig. 5
Papustyla hindei (Cox) Specimen with uterus filled with eggs.

Length	Width	
48.0 mm.	25.0 mm.	Wide Bay, New Britain
47.0 mm.	25.8 mm.	Wide Bay, New Britain
41.5 mm.	23.3 mm.	Wide Bay, New Britain
42.0 mm.	22.0 mm.	Lower Mewoulou River, Wide Bay, New Britain.

Types: The holotype of *Cochlostyla hindei* Cox is in the Australian Museum, Sydney, No. C. 62674. The type locality New Ireland is in error. This species is known only from New Britain.

Remarks: The shell proper is a light pinkish brown, the periostracum being a shiny and somewhat uniform brown. The coloration of the brownish lip, the sub-sutural line and the columellar band of colour are invested in the shell proper and not in the periostracum.

Range: Found only on New Britain Island.

Specimens examined: BISMARCK ARCHIPELAGO. New Britain: Wide Bay (MCZ); Wide Bay, Lower Mewoulou River (MCZ; ANSP); Ralum (AM).

Papustyla novaepommeraniae (I. & B. Rensch)
Pl. 1, fig. 6.

Papuina novaepommeraniae I. & B. Rensch 1929, Zoologische Anzeiger 80: 77. (Mountains at Matlip, Weiten Bucht [Wide Bay], Neu Pommern [New Britain], Bismarck Archipelago); I. Rensch 1934, Archiv für Naturgeschichte (n.s.) 3: 466.

Papuina papustyloides I. & B. Rensch 1929, Zoologische Anzeiger 80: 78 (Matlip and Waltoe, Weiten Bucht [Wide Bay], Neu Pommern [New Britain], Bismarck Archipelago); I. Rensch 1934, Archiv für Naturgeschichte (n.s.) 3: 466.

Description: Shell extended, conic, rather light in structure, reaching about 38 mm. in length, imperforate and smooth. Whorls six, slightly convex and with last whorl having a slight keel at the periphery. Colour a light greenish brown, being much lighter, however, to almost white on the early whorls. There is a narrow band, white overlaid by the yellowish periostracum at the whorl periphery. Spire extended and produced at an angle of 45°. Aperture subovate. Parietal lip consisting of a very thin glaze. Palatal lip narrow, reflected, white in colour and produced at an angle of 40° from the base. Columella nearly straight and somewhat wider at its basal margin. Suture well defined and margined below by a very narrow band. Sculpture consisting of exceedingly fine, oblique and irregular growth lines. Nuclear whorls one and a half, smooth and white.

Length	Width	Whorls	
37.5 mm.	22.0 mm.	6½	Holotype of *P. novaepommeraniae* (Rensch).
38.5 mm.	23.8 mm.	6½	Paratype of *P. novaepommeraniae* (Rensch).
33.5 mm.	20.5 mm.	6½	Holotype of *P. papustyloides* (Rensch).
35.1 mm.	22.2 mm.	6½	Paratype of *P. papustyloides* (Rensch).
38.3 mm.	22.5 mm.	6	Matlip, Wide Bay, New Britain Is.

Types: The holotypes of both *P. novaepommeraniae* and *P. papustyloides* are in the Zoologischen Museum, Berlin. A paratype of *P. novaepommeraniae* is in the Museum of Comparative Zoology, No. 83855. The type locality is Matlip, Wide Bay, New Britain, Bismarck Archipelago.

Remarks: This species appears to be nearest in relationship to *P. pulcherrima* of Manus Island. The striking difference is, of course, the amazing green colour of *pulcherrima*, but in the morphology of the shell the two appear to be very close. From *P. fergusoni* it differs by having more convex whorls and as a consequence a less pronounced keel. In addition, it has a much narrower lip and columella. It does not appear to be closely related to *P. hindei* of this same island.

Range: Known only from the vicinity of Wide Bay, New Britain.

Specimens examined: BISMARCK ARCHIPELAGO. New Britain: Matlip, Wide Bay (MCZ).

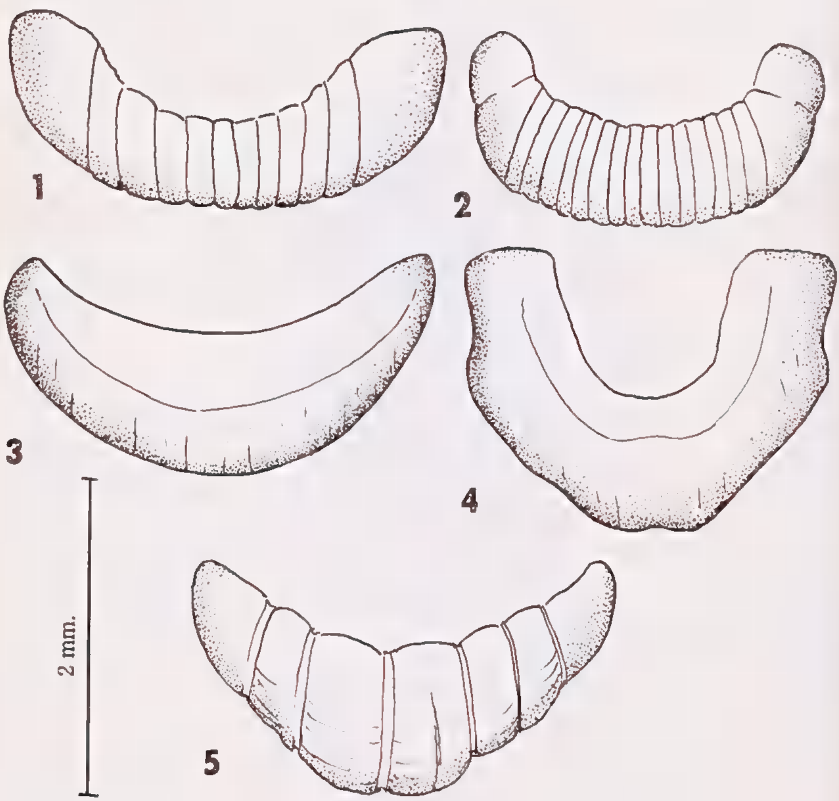

Fig. 6
Jaws

Fig. 1, *Papustyla pulcherrima* (Rensch).
Fig. 2, *Papustyla hindei* (Cox).
Fig. 3, *Meliobba popondetta* Clench and Turner.
Fig. 4, *Meliobba mcmichaeli* Clench and Turner.
Fig. 5, *Meliobba helenae* Clench and Turner.

Papustyla chancei (Cox)
Pl. 1, figs. 2-3.

Helix chancei Cox 1870, Proc. Zoological Society, London, p. 171, pl. 16, fig. 5 (Isabel Island, Solomon Islands).

Helix (Papuina) amphizona Pilsbry 1891, Manual of Conchology (2) 7: 5, pl. 8, fig. 52-54 (Solomon Islands).

Papuina chancei rechingeri Oberwimmer 1909, Denkschriften Akademie der Wissenschaften, Wien 84: 515, pl. 1, fig. 1a-c (Buin, Bougainville Is., Solomon Islands).

Papuina chancei var. *alba* Leschke 1912, Jahrbuch der Hamburgischen Wissensch. Anstalten 29: 101, fig. 6. (Meim Bay, south coast Neu Pommern Is. [New Britain], Bismarck Archipelago).

Papuina josephi Rensch 1930, Zoologischer Anzeiger 92: 226, text fig. 2 (Mensal-Bach, Henry Reid Bay, Neu Pommern [New Britain]).

Papuina chancei (Cox). Rensch 1934, Archiv für Naturgeschichte (n.s.) 3: 460, text figs. 5-7.

Description: Shell conic, rather light in structure and reaching about 34 mm. in length, imperforate and smooth. Whorls six to six and a half slightly convex, the last whorl broadly angled. Colour usually light ivory and may be banded with broad bands of dark chocolate-brown above and below the periphery. In others these bands are a very light brownish yellow and in still others the bands may be entirely absent. Rarely the dark bands completely suffuse the shell. The shells are usually rendered somewhat darker by the light yellowish periostracum. The apical whorls may be very dark brown or entirely white. Reflected lip usually white with the area immediately behind much darker. Inner edge of columella usually light in colour and much darker behind. Spire extended and produced at an angle of about 70°. Aperture subquadrate. Parietal lip consisting of a very thin glaze. Palatal lip reflected, broadly and slightly indented at the peripheral area and produced at an angle of 40° from the base. Columella sloping and rather broad. Suture well defined. Sculpture consisting of numerous fine growth lines which are crossed by exceedingly fine and poorly defined threads. Nuclear whorls one and a half and smooth and these may be dark brown or whitish.

Length	Width	
31.0 mm.	30.6 mm.	Wide Bay, New Britain.
33.0 mm.	31.0 mm.	Gazelle Peninsula, New Britain.
33.5 mm.	31.5 mm.	Paratype of *P. chancei rechingeri* Ober.

Types: The holotype of *Helix chancei* Cox is in the Australian Museum, Sydney, Australia, No. C. 62379. A paratype is in the Museum of Comparative Zoology No. 94950. The holotype of *Helix (Papuina) amphizona* Pilsbry is in the Academy of Natural Sciences, Philadelphia, No. 61908. The holotype of *P. chancei rechingeri* Oberwimmer is in the Natural History Museum, Vienna; paratypes are in the Museum of Zoology, University of Michigan, Ann Arbor, Michigan. The holotype of *Papuina chancei alba* Leschke was in the Hamburg Museum, Germany, but was possibly destroyed during World War II. The holotype of *P. josephi* Rensch is in the Berlin Museum. The type localities as given for *chancei* (Isabel Island, Solomon Islands); *amphizona* Pils. (Solomon Islands?);

and *rechingeri* Oberwimmer (Buin, Bougainville) are all in error. So far as we can now determine, this species is definitely known to occur only on New Britain Island in the Bismarck Archipelago.

Remarks: This is a very distinctive species as it is proportionately much wider in relation to its length than other known species of *Papustyla*. It appears to be most closely related to *P. fergusoni* from which it differs in having more globose whorls, a rounded keel at the whorl periphery and in being nearly smooth.

The anatomy of the reproductive system of *P. chancei* as illustrated by I. Rensch (1934, fig. 6) is close to that of *P. hindei*, differing mainly in the greater length of the penis. The radula is also close to that of *hindei* and *pulcherrima*.

Range: Known only from New Britain and the Vitu Islands, Bismarck Archipelago.

Specimens examined: BISMARCK ARCHIPELAGO. New Britain: (USNM; MCZ; UM; BMNH); Gazelle Peninsula (UM); Wide Bay and Rabaul (both MCZ); Kailai, Wide Bay; Luvelau (both ANSP). Vitu or French Islands: Unea (MCZ); mountains of Matlip (ANSP); Ralum (AM).

Papustyla fergusoni (H. Adams)
Pl. 1, figs. 7-8.

Geotrochus fergusoni H. Adams 1872, Proc. Zoological Soc., London, p. 614, pl. 42, fig. 14 (New Britain Island [Bismarck Archipelago]).

Helix (Papuina) fergusoni H. Adams. Pilsbry 1891, Manual of Conchology (2) 7: 32, pl. 3, fig. 54.

Papuina fergusoni fergusoni H. Adams. I. Rensch, 1934. Archiv für Naturgeschichte (n.s.) 3: 469.

Papuina schneideri I. & B. Rensch 1929, Zoologischer Anzeiger 80: 77 [not figured], (Mope, Gazelle Halbinsch, Neu Pommern [New Britain]; I. Rensch 1934, Archiv für Naturgeschichte (n.s.) 3: 469.

Description: Shell extended, conic, rather light in structure reaching 32 mm. in length, imperforate and sculptured. Whorls six, nearly flat-sided and sharply keeled at the whorl periphery. Colour a nearly uniform straw-yellow. Outer lip white and outer portion of the umbilical area tinged with reddish brown. Spire extended, produced at an angle of about 50°. Aperture subquadrate. Parietal wall thinly glazed. Palatal lip reflected, and in profile view showing a papuinoid notch. The lip is produced at an angle of 45° from the base. Columella broadly arched. Suture well defined but only slightly indented. Sculpture consisting of rather coarse growth lines. Nuclear whorls two and smooth.

Length	Width	
32 mm.	28 mm.	New Britain, Holotype of *G. fergusoni*
30 mm.	27 mm.	New Britain, Holotype of *P. schneideri*

Types: The location of the holotype of *Geotrochus fergusoni* H. Adams is unknown to us. It is not in the British Museum (Natural History). The type locality is New Britain, Bismarck Archipelago. The holotype of *P. schneideri* Rensch is in the Zoologischen Museum, Berlin, from Mope,

Gazelle Peninsula, New Britain. A paratype from the same locality is in the Museum of Comparative Zoology, No. 225205.

Remarks: We have seen only a single specimen of this species and so cannot give any statement as to its variation or range of distribution. It appears to be most closely related to *P. chancei* Cox from which it differs by being smaller, more sharply keeled and by having flat-sided whorls. Unfortunately, Adams made all of his comparisons of *P. fergusoni* with *P. turris* Adams from Waigeu [Waigeo], New Guinea, a species of *Cymotropis*, a genus which simulates very closely attenuated *Papustyla*. I. Rensch (1934) placed *P. schneideri* I. and B. Rensch in the synonymy of *fergusoni* H. Adams.

Range: Known only from New Britain, Bismarck Archipelago.

Specimens examined: BISMARCK ARCHIPELAGO. New Britain: Mope (MCZ).

Papustyla fergusoni talaseana I. Rensch

Papuina talaseana I. Rensch 1929, Zoologischer Anzeiger 85: 50, text figure 2 (Talasea, Neu Pommern [New Britain], Bismarck Archipelago).

Papuina fergusoni talaseana I. Rensch 1934, Archiv für Naturgeschichte (n.s.) 3: 471.

Description: "Shell sharply conical, not umbilicate, solid, the apex blunted, six and a half to seven flat to slightly convex whorls, the last whorl descending; colour horn-yellow with dark brown to black spots, which are remnants of the original colour (the shells are somewhat bleached); the first two whorls white; suture thread-like (in two specimens not set off as a thread between the sixth and seventh whorls), in the larger specimen the last whorl somewhat concave close to and below the suture; surface irregularly rib-striate; upper and flatly convex under side provided with a fine, spiral sculpture; aperture rounded rectangularly; outer lip strongly reflected, white; inside of aperture also pure white; columellar margin oblique."

Length	Width	Whorls	
34.4 mm.	32.4 mm.	7	Holotype

Types: Holotype in the Zoologischen Museum, Berlin, Germany. The type locality is Talasea, Neu Pommern [New Britain], Bismarck Archipelago.

Remarks: We have not seen this subspecies and we give above a translation of the original description. As indicated in the synonymy above, I. Rensch in 1934 considered *talaseana* to be a subspecies of *P. fergusoni*. Lacking further evidence we are following this classification at this time. However, when additional material is available for study, *talaseana* may well prove to be a form of *P. chancei* Cox.

Range: Known only from Talasea, New Britain, Bismarck Archipelago.

Papustyla xanthochila (Pfeiffer)

Pl. 1, fig. 4; Pl. 3, fig. 6; Fig. 3(6).

Helix xanthochila Pfeiffer 1860, Proc. Zoological Society, London, p. 192 (Solomon Islands); Pfeiffer 1861, Novitates Conchologicae (1) 2: 175, pl. 47, figs. 5-6.

Description: Shell extended, conic, rather light in structure, reaching about 47 mm. in length, perforate and smooth. Whorls six and a half, moderately convex, and the last whorl without a keel. Colour a china-white, shining, and the inner face and edge of the lip a deep yellow to orange-yellow. Spire extended and produced at an angle of about 58°. Aperture subquadrate. Parietal lip consisting of a very thin glaze. Palatal lip reflected, somewhat thickened and obtusely pointed at the peripheral area. In profile, the lip is very flatly sigmoid and is produced at an angle of 55° from the base. Columella nearly straight and somewhat broadened, partially concealing the umbilicus. Suture well defined. Sculpture consisting of exceedingly fine oblique growth lines. There appears to be no trace of any spiral sculpture. Nuclear whorls one and a half and somewhat discoloured with a light brownish coloration.

Only a single preserved specimen of *Papustyla xanthochila* was available for study and this was in such poor condition that an illustration could not be made. Sufficient facts could be gained from this specimen, however, to state that the anatomy of the reproductive system is very close to that of *P. pulcherrima.* The penis is large, thin walled, and with a large penis papilla.

The radula of *xanthochila* is unique in having very little change in the shape of the teeth from the first lateral to the outermost marginal. The teeth are very long, narrow, closely set, and arranged in broadly V-shaped rows. This is very close to what Pilsbry has shown for *P. vexillaris* Pfeiffer. The jaw in the single specimen was too fragmented to illustrate, but it is definitely ribbed.

Length	Width	
45.0 mm.	30.0 mm.	Buin, Bougainville.
45.5 mm.	28.5 mm.	Moran Village, Bougainville.
46.0 mm.	28.2 mm.	Kokore Village, Bougainville.

Types: The holotype is in the Cuming collection, now in the British Museum. The type locality is here restricted to Buin, Bougainville Island, Solomon Islands. So far as known, this species is restricted to Bougainville Island.

Remarks: For comparisons see *Remarks* under *P. lilium.*

Range: Known only from Bougainville Island, Solomon Islands.

Specimens examined: SOLOMON ISLANDS. Bougainville Island: (USNM; CM; ANSP; BPBM); Moran Village; Kokore Village; Buin (all AMNH and MCZ).

Papustyla lilium (Fulton)
Pl. 1, fig. 5; Pl. 3, fig. 7.

Helix (Geotrochus) xanthochila var. Cox, 1873, Proc. Zoological Soc., London, p. 567, pl. 48, fig. 7 (no locality given).

Papuina lilium Fulton 1905, Jour. of Malacology 12: 22, pl. 6, fig. 4a-b (Solomon Islands).

Description: Shell white, extended, conic, rather light in structure and reaching 46 mm. in length, umbilicate and smooth. Whorls six, moderately convex and the last whorl without a keel. Lip broadly reflected, coloured white, and the back of the extended lip strongly crenulated. The

spire is not straight sided as in *xanthochila* but is slightly convex and, in addition, *lilium* has smaller nuclear whorls than *xanthochila*. In all other respects the two species are quite similar.

Length	Width	
46.0 mm.	35.5 mm.	Sasamanga River, Choiseul Island.
42.5 mm.	33.0 mm.	Luti, Choiseul Island.
43.0 mm.	33.5 mm.	Choiseul Island, Paratype.

Types: The holotype of *Papuina lilium* Fulton is in the British Museum (Natural History), No. 1905-10-23-88; a single paratype is in the Museum of Comparative Zoology, No. 151955. We here restrict the type locality to Luti, Choiseul Island, Solomon Islands. An additional paratype is in the Academy of Natural Sciences, Philadelphia, No. 94271.

Remarks: This species, though closely allied to *P. xanthochila*, differs remarkably in certain of its characters. It differs mainly in having a far more broadly expanded lip, almost double that of *P. xanthochila*. The lip is white and, in addition, is strongly crenulated with rather deeply impressed grooves on its outer surface. The spire is slightly concave and not straight-sided and the nuclear whorls are much smaller than those found in *P. xanthochila*.

Range: Known only from Choiseul Island, Solomon Islands.

Specimens examined: SOLOMON ISLANDS. CHOISEUL ISLAND: (UM; USNM; MM; ANSP); Luti; banks of Sasamanga River (both AMNH; MCZ).

FORCARTIA[1], new genus

Shells imperforate, globose to subglobose, smooth or with fine spiral sculpture. Papuinoid notch absent or only faintly indicated. Whorls globose with no indication of a peripheral keel.

Type species: *Papuina buehleri* Rensch.

Papuina globula Rensch is included in this genus on a tentative basis. Lack of a colour pattern and the presence of a fine spiral sculpture may eventually exclude this form when the soft anatomy of both forms has been examined.

Forcartia is known only from Manus Island, Admiralty Archipelago and New Britain Island, Bismarck Archipelago.

No anatomical material is available for these two species. The shells, however, differ from those of all other genera in these two archipelagoes by being globose rather than depressed or attenuated. *Forcartia buehleri*, in addition, has a very different colour pattern.

In distribution this genus is like *Papustyla*, having species on Manus Island in the Admiralty group and New Britain Island in the Bismarck Archipelago with no known species from New Ireland or the many smaller islands between New Britain and Manus.

[1] Named for Dr. Lothar Forcart of the Naturhistorisches Museum, Basel, Switzerland.

Forcartia bühleri (Rensch)
Pl. 3, figs. 3, 4.

Papuina bühleri Rensch 1933, Zoologischer Anzeiger 102: 315, fig. 3 (Tungon, Manus Island, Admiralty Islands).

Description: Shell subglobose, rather light in structure, reaching about 35 mm. in greater diameter, imperforate and smooth. Whorls five and strongly convex. Ground colour a light yellowish brown. There is developed a narrow peripheral line of dark mahogany-brown which generally broadens to a wide brownish band on the body whorl or on the last two whorls. The entire shell is flecked with rather small zigzag markings of light yellow, generally in axial arrangement, initiated on the periphery and at the suture and extending below for a short distance. Spire broad and formed at an angle of 85°. Aperture subcircular to subquadrate, the outer lip forming an angle of 40° from the base. Behind the lip the aperture is very slightly constricted and turned down slightly toward the base. Parietal lip consisting of a very thin glaze. Palatal lip reflected, very slightly sigmoid in a profile view. Columella very short, somewhat broad, the thickened area extending obliquely towards the base of the lip. There is a small tooth-like process evolved midway between the columella and the base of the shell. Umbilical area slightly depressed and coloured a dark mahogany-brown. Sculpture consisting of exceedingly fine growth lines. Nuclear whorls smooth and merging completely with the post nuclear whorls, leaving no line of demarcation.

Greater diameter	Lesser diameter	Height	
34.5 mm.	29 mm.	28.6 mm.	Paratype
31.2 mm.	26 mm.	24.0 mm.	Pundrau, Manus Is.

Types: Holotype and paratype, Naturhistorisches Museum, Basel, Switzerland; paratype in the Zoologischen Museum, Berlin from Tungon, Manus Island, Admiralty Islands.

Remarks: This is an exceedingly rare species so far as our collections indicate, only six specimens being known to us. *F. buehleri* is very different from any other known papuinid from the Admiralty Islands. It appears to be related but distantly to *Forcartia globula* (Rensch) from New Britain Island, the only other member of this genus. It differs from this species by lacking sculpture and by its type of coloration, *globula* being a uniform semi-opaque creamy white.

Range: Known only from Manus Island, Admiralty Archipelago.

Specimens examined: ADMIRALTY ARCHIPELAGO Manus Island: Tungon (Basel Museum); Pundrau at 1500 feet (BPBM); Lorengau (MCZ).

Forcartia globula (Rensch)
Pl. 3, fig. 5.

Papuina globula Rensch 1930, Zoologischer Anzeiger 92: 226, text fig. 1 (Pulie River, Cape Merkus, New Britain Is., Bismarck Archipelago).

Description: Shell subglobose, rather strong in structure, reaching about 29 mm. in greater diameter, imperforate and smooth. Whorls four

and strongly convex. Colour a uniform cream with a flush of pink at the umbilical area and on the reflexed lip from the umbilical area to the base. Nuclear whorls may or may not be faintly pinkish. Spire broad and formed at an angle of about 95°. Aperture subcircular, the outer lip forming an angle of 45° from the base. Back of the lip the aperture is slightly constricted and turned down slightly toward the base. Parietal lip consisting of a very light glaze. Palatal lip reflected with no indication of the papuinoid notch. Columella very short, rather broad, the thickened area extending obliquely toward the base of the lip. There is a small tooth-like process evolved midway between the columella and the base of the shell. Umbilical area depressed and coloured pink. Sculpture consisting of numerous and very fine, irregular, wavy threads. Nuclear whorls one and a half and nearly smooth, sculptured only with exceedingly fine and somewhat irregular growth lines.

Greater diameter	Lesser diameter	Height	
29.0 mm.	24.8 mm.	21 mm.	Pilelo Is., New Britain Is.
28.5 mm.	24.0 mm.	20 mm.	Pilelo Is., New Britain Is.

Types: Holotype in the Zoologischen Museum, Berlin, from Pulie River, Cape Merkus, New Britain, Bismarck Archipelago.

Remarks: This is an isolated species and very different from anything else known from the Bismarck Archipelago. See remarks under *F. buehleri* (Rensch).

Range: Known only from New Britain Island, Bismarck Archipelago.

Specimens examined: BISMARCK ARCHIPELAGO. New Britain: Pilelo Island, Cape Merkus (CM).

Genus *MELIOBBA* Iredale

Meliobba Iredale 1940, The Australian Naturalist 10: 240, text figures.

Negotobba Iredale 1941, The Australian Zoologist 10: 83, (type species, *Helix goldiei* Brazier).

Type species: *Meliobba shafferyi* Iredale, monotypic.

Shells rather large, lenticular to depressed globose, perforate or imperforate, sculptured, and generally with an acute angulation at the periphery. Colour grayish and usually marbled with purple to reddish brown. Sculpture consisting of irregular ridges or ripples which vary in the different species. Nuclear whorls smooth or with very small ridges emanating from the suture.

Meliobba occurs only in New Guinea and in Northern Queensland. Its distribution in New Guinea is extensive, from near the eastern end westward to at least the region about Hollandia on the north coast. On the south coast of New Guinea *Meliobba* has been reported only as far west as Orokolo, Gulf Division.

Key to the species of *Meliobba*

1.	Shell imperforate	2
	Shell umbilicate	3
2.	Sculpture of interlacing spiral ridges; aperture often with a basal tooth	*shafferyi*
	Sculpture of fine oblique axial threads; aperture lacking a basal tooth	*helenae*
3.	Shell lenticular	*lintschuana*
	Shell depressed globose	4
4.	Peripheral keel of the body whorl acute	5
	Peripheral keel of the body whorl narrowly rounded ..	*popondetta*
5.	Spire dome-shaped, formed at an angle of about 110°; spiral sculpture on the base of the body whorl very weak and not interlacing	*mcmichaeli*
	Spire depressed and formed at an angle of about 125°; sculpture on the base of the body whorl of strong interlacing spiral ridges	*goldiei*

Meliobba goldiei (Brazier)
Pl. 2, fig. 4; Pl. 3, figs. 1, 2.

Helix goldei [sic] Brazier 1880 [1881], Proc. Linnean Soc., New South Wales 5: 637 [nomen nudum].

Helix (Obba) oxystoma E. A. Smith 1883, Annals and Magazine of Natural History (5) 11: 191 (D'Entrecasteaux Island off SE Coast of New Guinea); non Thomae 1845.

Helix (Obba) goldiei Brazier 1884, Proc. Linnean Soc., New South Wales 9: 804 [new name for *Helix oxystoma* Smith 1883, non Thomae 1845].

Description: Shell reaching about 42 mm. in greater diameter, discoidal, solid in structure, perforate and sculptured. Whorls four, flattened, having a well developed peripheral keel and with the aperture descending sharply about one centimeter from the lip. Colour a light brownish gray, mottled with dark mahogany to purple, particularly on the body whorl. Spire depressed, obtuse, and produced at an angle of 125°. Aperture broadly ovate and cast at an angle of about 30° from the base. Parietal lip consisting of a small, slightly thickened area or only glazed with dark, mahogany-brown. Palatal lip white and reflected. Columella short, broad and black within. Suture slightly impressed. Umbilicus rather small but deep and partially covered by the columellar reflection. Sculpture consisting of fine, irregular, embossed, interlacing, spiral ridges which are white, the coloration of the shell being mainly in the depressed areas. Nuclear whorls about two, rather large, coloured a reddish brown, smooth and with a few, short, comma-like ridges which emanate from the suture.

Greater diameter	Lesser diameter	Height	
42.5 mm.	34.5 mm.	20.0 mm.	Near Port Moresby.
41.0 mm.	33.1 mm.	21.5 mm.	Inland from Yule Island.
40.5 mm.	33.0 mm.	21.5 mm.	Owen Stanley Range.

Types: The holotype of *M. oxystoma* is in the British Museum (Nat. Hist.) No. 83.1.6.1. According to Brazier, the type locality is "the foot of Mt. Astrolabe" which is inland from Port Moresby. The locality D'Entrecasteaux Island, originally cited by E. A. Smith, is in error.

Remarks: The six species so far known in *Meliobba* are rather distinct. *M. lintschuana* Kobelt differs from *M. goldiei* Brazier by being a little smaller, having much finer sculpture, and having the glaze on the parietal area uncoloured. In *M. goldiei* the parietal glaze is a rather dark mahogany-brown. Both these species differ from *M. shafferyi* by being perforate. In addition, this last species has occasionally a well developed tooth on the base of the lip in fully grown specimens.

Range: Known only from New Guinea, extending from Orokolo, Gulf Division south-east to Cloudy Bay, Eastern Division and up to 8000 feet elevation.

Specimens examined: NEW GUINEA: Foot of Mt. Astrolabe (UM); Laloki River, north of Port Moresby (UM); Rouna Falls, Laloki River, 20 miles east of Port Moresby (NMV); near Port Moresby; Inland from Yule Island (both MCZ); Owen Stanley Range at 8000 feet (MCZ; USNM); Cloudy Bay; Manvagolo, 25 miles ENE of Port Moresby; Mt. Astrolabe; Orokolo (all AM).

Meliobba lintschuana (Kobelt)
Pl. 2, fig. 2.

Helix (Papuina) lintschuana Kobelt 1894, Conchylien-Cabinet (2) 1, pt. 12, sec. 4, p. 701, pl. 200, figs. 5, 6 (Djamna Island, New Guinea).

Description: Shell reaching about 39 mm. in greater diameter, solid in structure, perforate and sculptured. Whorls four, depressed and having a well developed peripheral keel, and having the aperture descending sharply about 8 mm, from the lip. Colour a dull gray, very slightly marbled with irregular and small patches of purple. Spire reduced and obtuse and cast at an angle of about 120°. Aperture broadly ovate and produced at an angle of 40° from the base of the shell. Parietal lip thinly glazed and clear with the normal gray colour of the shell showing through. Palatal lip white and rather broadly reflected. Columella short and somewhat broadened. Suture slightly impressed. Umbilicus rather small but deep and almost wholly covered by the columellar reflection; this reflection, however, is not appressed to the shell. Sculpture consisting of rather fine, irregular and embossed ridges which are crossed by innumerable, fine, growth lines. Nuclear whorls about two, rather large, coloured a light gray and with numerous, regularly spaced thread-like ridges emanating from the suture.

Greater diameter	Lesser diameter	Height	
38.0 mm.	29.0 mm.	20 mm.	Holotype.
36.5 mm.	28.5 mm.	15 mm.	Hollandia.
33.5 mm.	27.0 mm.	14 mm.	Hollandia.

Types: The holotype is said by Kobelt to be in the Strubel collection. The type locality is Djamna [Jamna] Island off the north coast of Dutch New Guinea.

Remarks: See under *M. goldiei* (Brazier).

Range: Known only from Jamna Islands and the vicinity of Hollandia, north coast of Dutch New Guinea.

Specimens examined: DUTCH NEW GUINEA, JAMNA ISLAND (type locality); Hollandia (CM).

Meliobba mcmichaeli, new species
Pl. 2, fig. 3; Figs. 3(2), 6(4), 7.

Description: Shell reaching about 42 mm. in greater diameter, discoidal, solid in structure, perforate and finely sculptured. Whorls four and a quarter, depressed and having a well developed peripheral keel which becomes somewhat flattened a short distance back from the aperture. Aperture descending about one centimetre from the lip. Colour a dull ivory with exceedingly irregular and diagonal bands of dark mahogany-brown. Spire depressed, obtuse and produced at an angle of about 110°. Aperture broadly ovate and cast at an angle of about 37°. Parietal lip thinly glazed. Palatal lip ivory in colour, reflected, and lacking a tooth on its inner side. Columella short and relatively broad. Suture slightly impressed. Umbilicus partially covered over by the columellar reflection. Sculpture consisting of numerous fine, irregular ridges which cover the shell surface and which are set obliquely above the periphery and spirally on the base of the shell. Nuclear whorls two, ivory in colour, having small and very fine comma-like ridges at the suture.

The reproductive system of *Meliobba mcmichaeli*, as shown in Fig. 7, is characterized by having a relatively long, thin penis with a proportionately large recurved epiphallus and a large flagellum. The basal portion of the wall of the penis has a few large muscular ridges while the upper third is thin-walled. The penis papilla of the single specimen available for dissection was small. The spermatheca is globular and the spermathecal duct short.

The radula is very similar to that of *popondetta* and *helenae* and the jaw is smooth.

Greater diameter	Lesser diameter	Height	
42.5 mm.	32.5 mm.	23.5 mm.	Paratypes.
41.0 mm.	31.5 mm.	27.5 mm.	Holotype.

Types: Holotype, the Australian Museum, Sydney, Australia, No. C. 62377, from Noorweg, Hollandia, Dutch New Guinea.

Remarks: This species differs from *Meliobba goldiei* Brazier, by having far less sculpture and by having an axial rather than a spiral type of colour pattern, having a less open umbilicus, and by having a somewhat more extended spire. From *M. shafferyi* it differs by having less sculpture, by being partially umbilicate, and in lacking the tooth on the base of the outer lip.

We take pleasure in naming this species after Donald F. McMichael, Curator of Molluscs in the Australian Museum.

Range: North coast of New Guinea in the vicinity of Humboldt Bay.

Specimens examined: DUTCH NEW GUINEA: Noorweg, Hollandia (AM); AUSTRALIAN NEW GUINEA: Angriffs Haven, about 30 miles east of Humboldt Bay (AM).

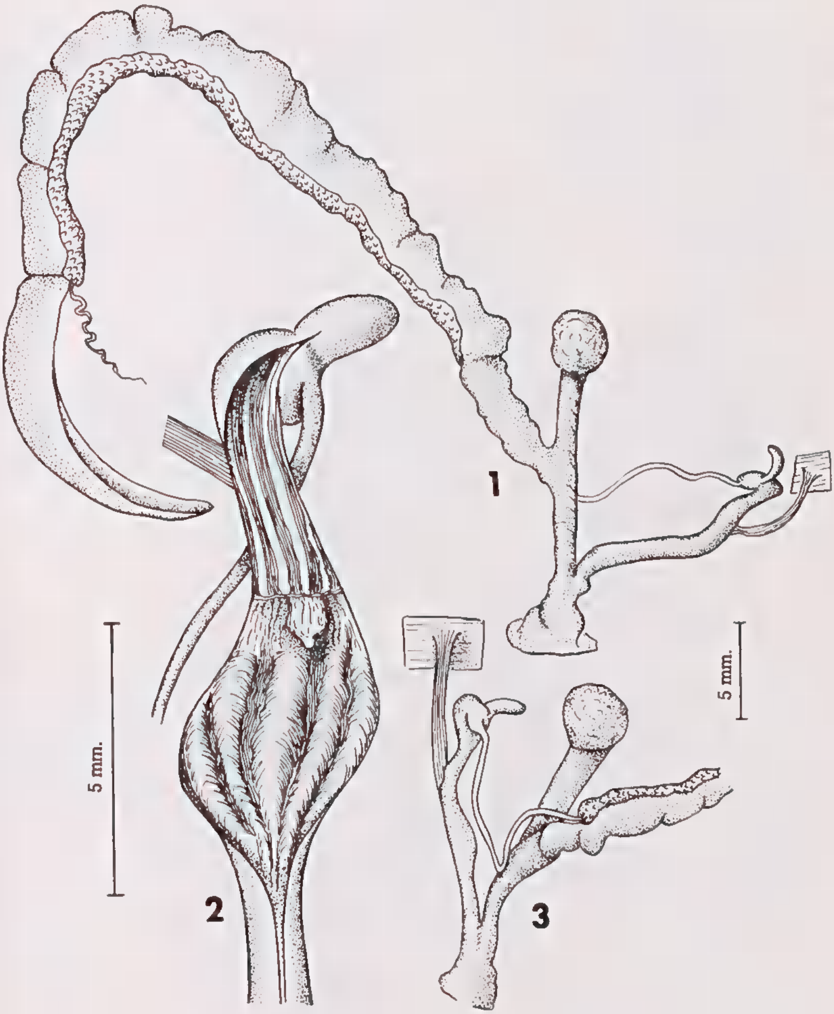

Fig. 7

Anatomy of the reproductive system of *Meliobba mcmichaeli* Clench and Turner. Fig. 1, complete system. Fig. 2, dissected penis. Fig. 3, basal area of reproductive system reversed. See Fig. 8 for labelling.

Meliobba popondetta, new species
Pl. 2, fig. 1; Figs. 3(3), 6(3), 8.

Description: Shell reaching 35 mm. in greater diameter, discoidal, solid in structure, perforate and finely sculptured. Whorls four, depressed, with the periphery of last whorl becoming rounded about half whorl before the aperture. Aperture descending sharply about 8 mm. from the lip. Colour a light brownish gray, mottled with dark mahogany to nearly black and having a well defined peripheral band of brown to brownish black. Spire depressed, obtuse and produced at an angle of about 120°. Aperture broadly ovate and cast at an angle of about 30° from the base. Interior of aperture a dark gray on the palatal wall. Parietal area thinly glazed with mahogany-brown. Palatal lip white and reflected. Columella short, broad and black within. Suture slightly impressed. Umbilicus large, deep, and only slightly covered by the columellar reflection. Sculpture consisting of fine, irregular and inconspicuous ridges which are more or less spirally arranged. Sculpture on the base of the whorl fine, becoming a little coarser near the aperture. Nuclear whorls two, light pinkish brown, smooth with a few exceedingly fine comma-like ridges emanating from the suture.

The reproductive anatomy of *Meliobba popondetta* is characterized by having the duct of the spermatheca short and large, the spermatheca being only slightly larger in diameter than the duct. The penis has a large recurved epiphallus and a small flagellum. The lower portion of the penis is thick walled and has pronounced longitudinal muscular ridges. The upper portion is thin walled and only slightly ridged. The penis papilla is small, triangular in outline and smooth. Only a single specimen was available for dissection.

The radula of *M. popondetta* is very close to that of *M. mcmichaeli* and *helenae* as shown in Fig. 3. The jaw is smooth.

Greater diameter	Lesser diameter	Height	
35.0 mm.	29.0 mm.	20.0 mm.	Holotype.
35.0 mm.	29.0 mm.	19.0 mm.	Paratype.
32.5 mm.	27.5 mm.	19.5 mm.	Paratype.

Types: Holotype, Australian Museum, No. C. 62376 from Mamoo Estate, near Popondetta (about 12 miles S.-W. of Buna), Papua (148° 19′ East; 8° 46′ South), collected by D. F. McMichael, August 31, 1957. Paratypes are in the Museum of Comparative Zoology, No. 221417, from the same locality and from Popondetta in the National Museum of Victoria, Australia. Additional paratype specimens in the British Museum (Natural History), No. 1908.6.2.4, from the Kumusi River, west of Buna, Papua. Paratype specimens from Abau (10° 11′ S; 148° 42′ E) Papua are in the Australian Museum.

Remarks: This species is close in its relationship to *Meliobba goldiei* Brazier. It differs in being somewhat smaller, having a rounded, rather than keeled, body whorl, and in having a larger and less covered umbilicus. From *M. lintschuana* Kobelt it differs in being far less strongly keeled and in being more openly umbilicate. In addition, the columellar area within is nearly black rather than white, and the shell is nearly circular rather than somewhat flattened on the last half of the body whorl as in *lintschuana*.

Range: Known only from the Buna-Popondetta Region, Northern Division, Papua, New Guinea.

Specimens examined. See under *Types.*

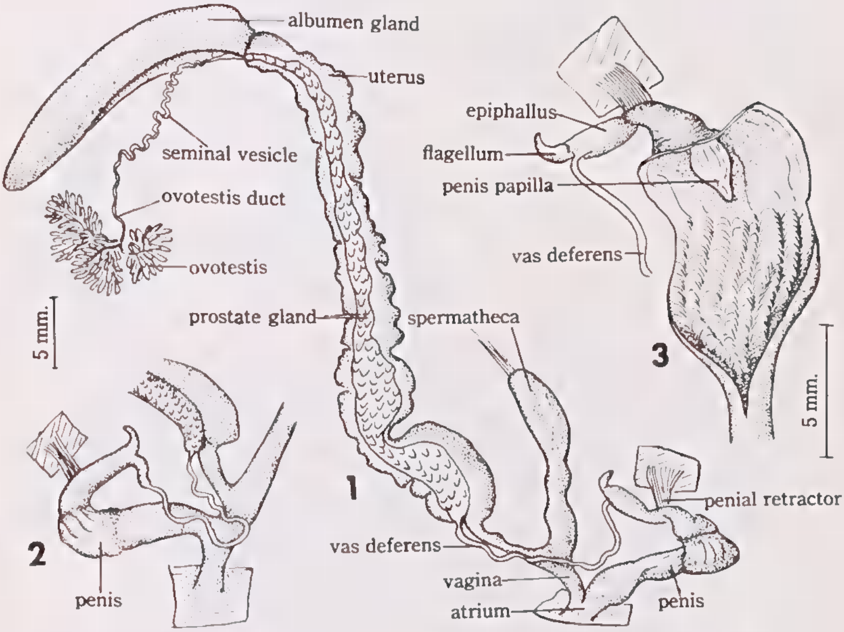

Fig. 8

Anatomy of the reproductive system of *Meliobba popondetta* Clench and Turner. Fig. 1, complete system. Fig. 2, basal area reversed. Fig. 3, enlarged drawing of the dissected penis.

Meliobba helenae Clench and Turner
Figs. 3(1), 6(5), 9.

Meliobba helenae Clench and Turner 1960, Journal of the Malacological Society of Australia, No. 4: 30, pl. 3.

For a description of this species see No. 4 of this Journal as noted above.

Known only from the type locality, Asai-Simbai Divide, Schrader Range, a few miles due west of Aiome, Territory of New Guinea (Aiome is at 05° 05′ South; 144° 50′ East).

The striking feature of the reproductive anatomy of *Meliobba helenae*, as shown in Fig. 9, is the short, thick penis which has a large, recurved

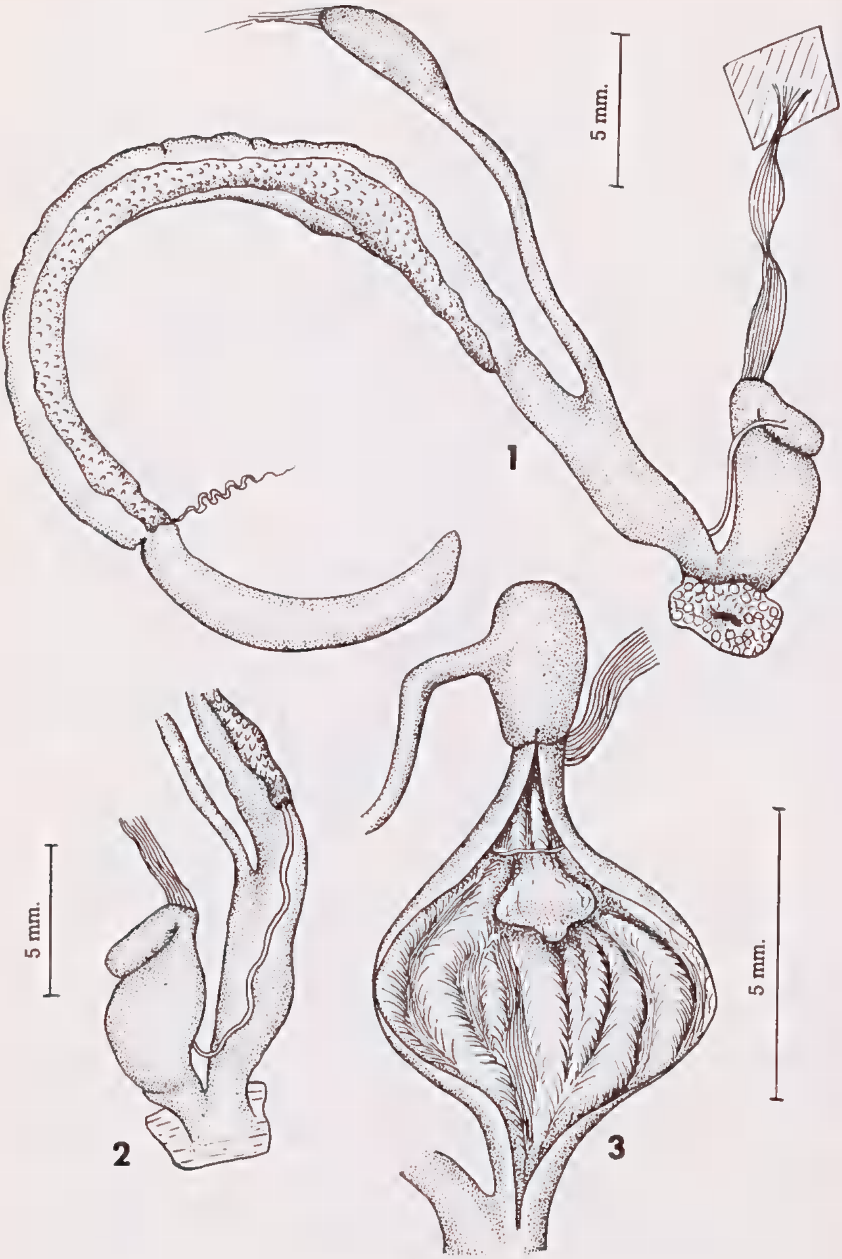

Fig. 9

Anatomy of the reproductive system of *Meliobba helenae* Clench and Turner. Fig. 1, complete system. Fig. 2, basal area reversed. Fig. 3, dissected penis. See Fig. 8 for labelling.

epiphallus with the vas deferens entering on the side of the epiphallus. The walls of the penis are thick and have a few large muscular ridges which diminish in size toward the epiphallus. The penis papilla is rather small, broad and smooth. The spermatheca is elliptical in outline, the spermatheeal duct short and nearly equalling the spermatheca in diameter. Only a single specimen of this species was available for dissection.

The radula of *M. helenae* is very close to that of *mcmichaeli* and *popondetta* but the jaw differs in being ridged rather than smooth.

Meliobba shafferyi Iredale
Plate 2, figs. 5, 6.

Meliobba shafferyi Iredale, 1940, Australian Naturalist 10: 239-240, text figures (near Mossman, Queensland, Australia).

Description: Shell reaching about 44 mm. in greater diameter, discoidal, solid in structure, imperforate and sculptured. Whorls five, flattened, having a well developed peripheral keel and having the aperture descending sharply about 1 cm. from the lip. Colour a shining greyish ivory on the ridges and purplish to reddish brown in the depressions. Behind the aperture and on the base, the periostracum is diffused with a rich yellowish brown coloration. Spire depressed, obtuse, and produced at an angle of about 115°. Aperture broadly ovate and cast at an angle of about 40° from the base. Parietal lip thinly glazed. Palatal lip white, reflected, and supporting a long, broad tooth near the base of the columella. Columella short and relatively broad. Suture slightly impressed. Umbilicus covered over by the columellar reflection which is completely fused to the body whorl. Sculpture consisting of numerous, irregular ridges which cover the shell surface and which are set obliquely above the periphery and spirally on the base of the shell. Nuclear whorls two, smooth, dark reddish brown in colour and lacking the comma-like ridges at the sutures.

Greater diameter	Lesser diameter	Height	
43 mm.	35 mm.	25 mm.	Holotype
44.5 mm.	37.5 mm.	21 mm.	Queensland

Types: The holotype of this species is in the Australian Museum, No. C. 62205, and is from Mt. Alexander, Mossman, North Queensland, Australia, J. Shaffery, collector. Paratype, Museum of Comparative Zoology, No. 235650.

Remarks: M. shafferyi and *M. helenae* differ from other species of *Meliobba* by being imperforate. Occasional specimens of *M. shafferyi* have a long and well-defined tooth on the basal margin of the outer lip.

Range: Known only from northern Queensland, Australia.

Specimens examined: See under *Types.*

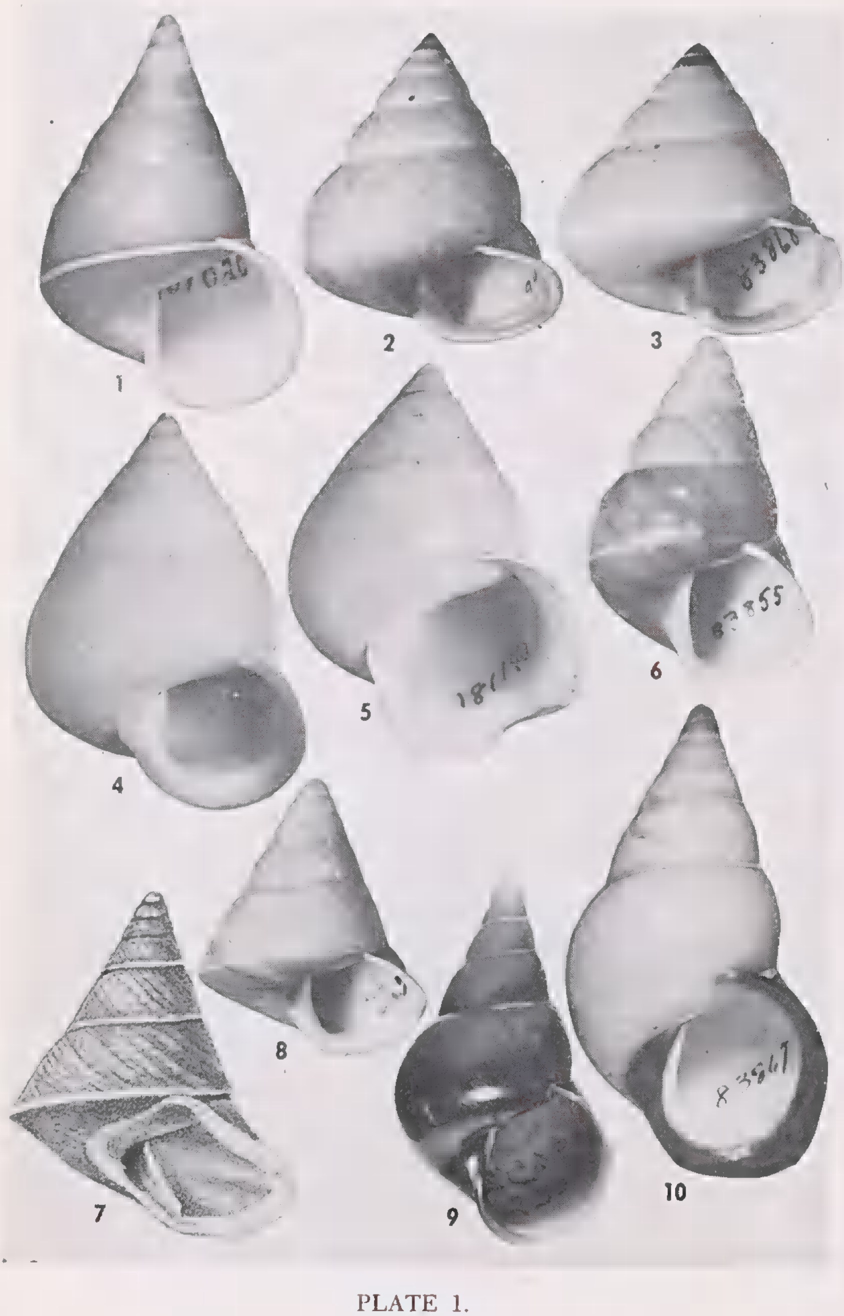

PLATE 1.

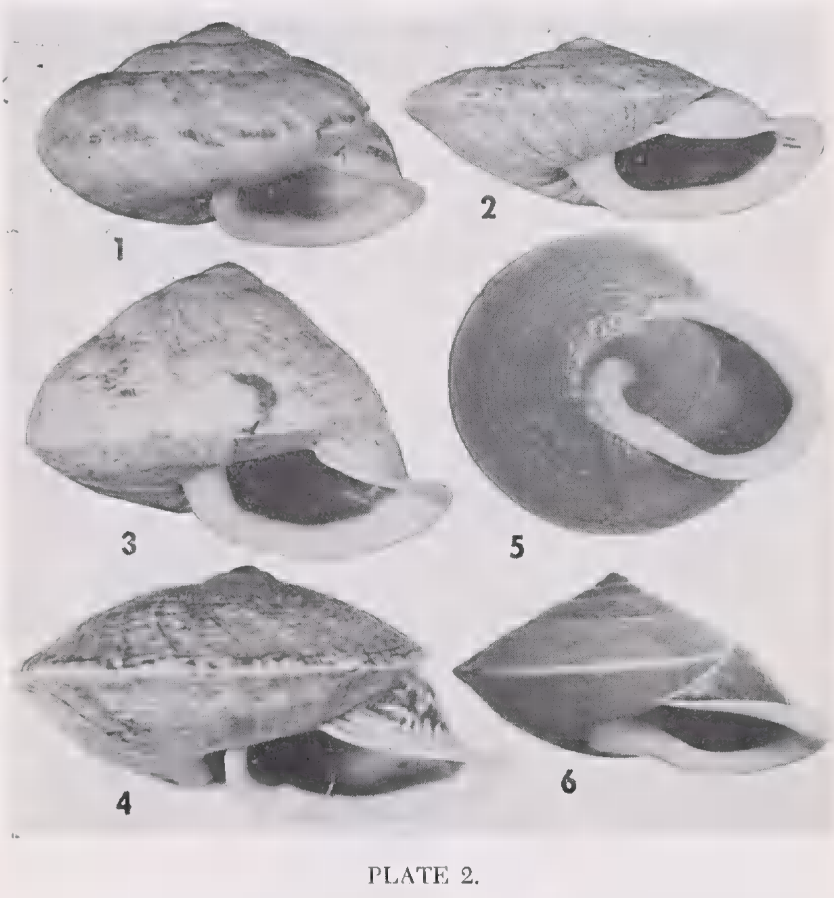

PLATE 2.

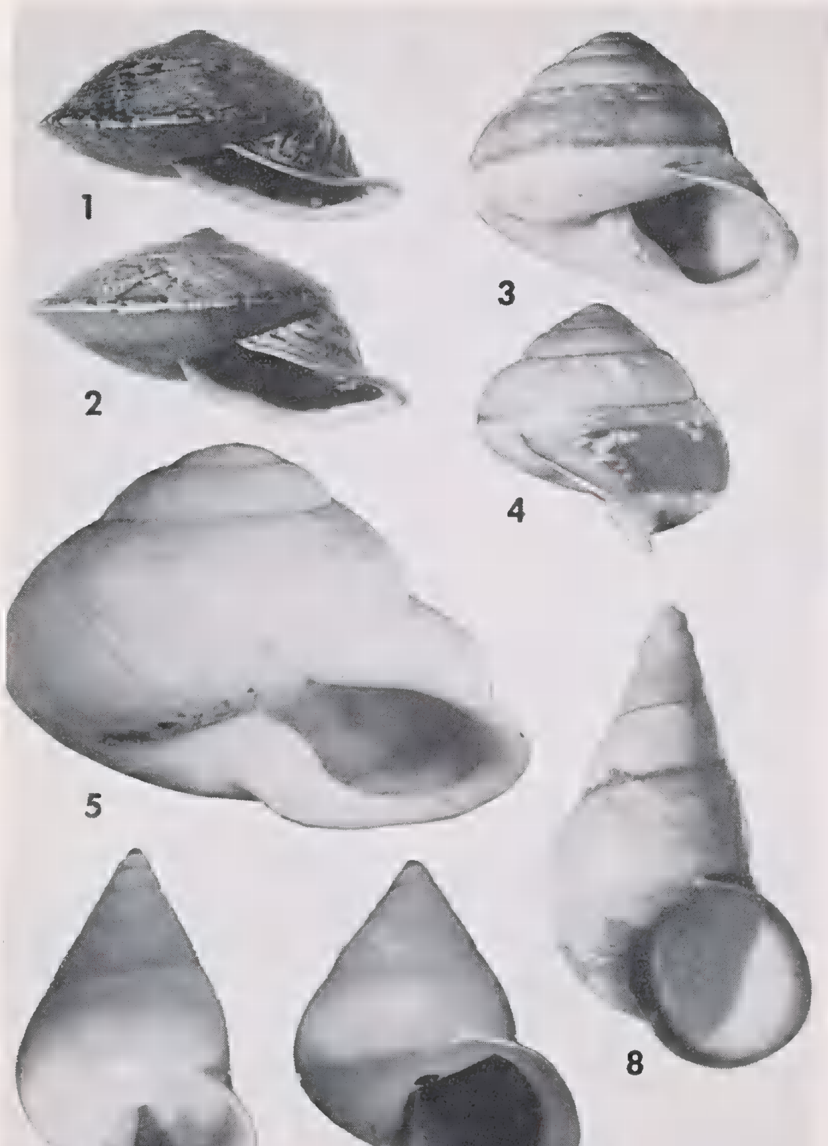

PLATE 3.

EXPLANATION OF PLATES 1-3.

PLATE 1.

Fig. 1: *Papustyla pulcherrima* (Rensch). Drabui Village, Manus Island, Admiralty Islands. M.C.Z. 181020 (1.12x)

Fig. 2: *Papustyla chancei* (Cox). Bismarcks. Paratype, M.C.Z. 94950 (1.27x).

Fig. 3: *Papustyla chancei* (Cox). Wide Bay, New Britain, M.C.Z. 83868 (1x).

Fig. 4: *Papustyla xanthochila* (Pfeiffer). Buin, Bougainville Island, Solomon Islands. M.C.Z. 216201 (1.1x).

Fig. 5: *Papustyla lilium* (Fulton). Sasamango River, Choiseul Island, Solomon Islands, M.C.Z. 181143 (about nat. size).

Fig. 6: *Papustyla novaepommeraniae* (I. & B. Rensch). Matlip, Wide Bay, New Britain, Bismarck Archipelago. Paratype, M.C.Z. 83855 (1x).

Fig. 7: *Papustyla fergusoni* (H. Adams). New Britain. From the Proc. Zool. Soc, London 1872, pl. 42, fig. 14 (1.26x).

Fig. 8: *Papuina schneideri* I. & B. Rensch. Mope, New Britain, Paratype. M.C.Z. 225205 (1.11x). (= *P. fergusoni* H. Adams).

Fig. 9: *Papustyla hindei* (Cox). Lower Mewoulou River, New Britain. M.C.Z. 235652 (1x).

Fig. 10: *Papustyla hindei* (Cox). Wide Bay, New Britain. M.C.Z. 83867 (about nat. size).

PLATE 2.

Fig. 1: *Meliobba popondetta* Clench & Turner. Popondetta, about 12 miles South-West of Buna, Papua. Holotype, Australian Museum C. 62376 (about 1.3x).

Fig. 2: *Meliobba lintschuana* (Kobelt). Hollandia, Dutch New Guinea. M.C.Z. 216896 (about 1.4x).

Fig. 3: *Meliobba mcmichaeli* Clench & Turner. Hollandia, Dutch New Guinea. Holotype, Australian Museum C. 62377 (about 1.5x).

Fig. 4: *Meliobba goldiei* (Brazier). Near Port Moresby, New Guinea. M.C.Z. 109291 (about 1.1x).

Fig. 5-6: *Meliobba shafferyi* Iredale. Mt. Alexander, Mossman, Queensland, Australia. Holotype, Australian Museum C. 62206 (about nat. size).

PLATE 3.

Fig. 1: *Helix (Obba) oxystoma* E. A. Smith. D'Entrecasteaux Island (error, probably from near Port Moresby, New Guinea). Holotype, British Museum (Nat. Hist.) 83.1.6.1 (nat. size). (= *M. goldiei* Brazier).

Fig. 2: The same, paratype 83.1.6.2 (nat. size).

Fig. 3: *Papuina buehleri* Rensch. Tungon, Manus Island, Admiralty Archipelago. Paratype, Basel Museum 39249 (1.2x).

Fig. 4: *Forcartia buehleri* (Rensch). Pundrau, Manus Island, Admiralty Archipelago. Bishop Museum 188867 (1.2x).

Fig. 5: *Forcartia globula* (Rensch). Pileto Island, Cape Merkus, New Britain. M.C.Z. 187688 (2.23x).

Fig. 6: *Helix xanthochila* Pfeiffer. Solomon Islands. Holotype, British Museum (Nat. His.), (nat. size).

Fig. 7: *Papuina lilium* Fulton. (Solomon Islands). Holotype, British Museum (Nat. Hist.) 1905.10.23.88. (about nat. size).

Fig. 8: *Cochlostyla hindei* Cox. New Britain. Holotype, Australian Museum C. 62674 (1.5x).

PAST AND PRESENT DISTRIBUTION IN AUSTRALIA OF THE GASTEROPOD *TYLOSPIRA*

By EDMUND D. GILL, B.A., B.D., F.G.S.*

Figure 1.

Summary: The family Struthiolariidae is represented in Australia by *Tylospira (Tylospira)* and *Tylospira (Singletonaria)*. Their geological history from the Miocene to the present is clarified. The only living representative is *Tylospira (T.) scutulata,* which is the type species of the genus.

Introduction: Shells of the marine snail *Tylospira scutulata* (Martyn) are commonly washed up on New South Wales beaches, but the species is not found alive because it belongs to the deeper water offshore. The shell is a smooth, turreted, strong skeleton of light fawn colour with an unusually shaped aperture and a claw-shaped operculum (Allan, 1950, p. 96). This is the only living species of *Tylospira.* The genus belongs to the family Struthiolariidae, which is limited to Australia, New Zealand, and South America, and ranges in time from the Mesozoic to the present. The Australian branch of the family consists only of the genus *Tylospira* (as now defined), which ranges in time from the Miocene to the present. In the seas of the past, *Tylospira* was often present in great numbers of individuals, but it apparently did not proliferate into numerous species.

UNUSUAL HABIT OF ADULT GROWTH

In most of its species, *Tylospira* is remarkable for its unusual adult growth, and indeed this is why Harris (1897) so named it. *Tylos* is Greek for a callosity, so *Tylospira* means the calloused spire. Dr. J. Marwick of New Zealand, who has made a study of the Struthiolariidae (Marwick 1950), describes the growth of *Tylospira* thus: "When the shell is about half-grown, the outer-lip is slightly reflexed and a moderate coating of callus is deposited on the convex edge. The callus extends adapically, parietally and basally, but it remains thin all over the inner lip so formed. The shell then continues to grow by increments of the glazed callus on the edge of the outer-lip and the end of the columella. Owing to some change in the part of the mantle that produces the surface sculpture, well-defined spiral cords and axial shoulder tubercles are no longer formed, weak spiral cords and cingula and low irregular, sinuous growth ridges taking their place. In *T. scutulata* this kind of growth goes on for about two whorls" (Marwick, 1960). This peculiar process of growth can be deciphered from some of the weathered specimens in which the various layers of shell substance become apparent.

FOSSIL RECORD

The fossil shell nearest to the living *Tylospira scutulata* (and so probably its direct ancestor) is *T. coronata* (Tate, 1888), which is common in the Lower Pliocene (Kalimnan) beds of the Gippsland Lakes district, in beds of the same age along Muddy Creek and Grange Burn, four miles west of Hamilton (Gill, 1957), and in similar beds on Spring Creek east of Minhamite railway station, 25 miles S.E. of Hamilton. Tate also recorded it from a well-sinking in the Murray desert. *Tylospira coronata* also occurs in Upper Miocene (Cheltenhamian) beds outcropping in the seaside cliffs at Beaumaris, and in other beds of the same age.

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* National Museum of Victoria, Melbourne.

The record of this species from still older rocks is apparently an error. For example, Dennant and Kitson (1903) listed *T. coronata* as appearing in the Upper Oligocene beds at Table Cape (= Fossil Bluff, Wynyard) in northern Tasmania. The shell on which this record is based was found in Dennant's collection in the National Museum of Victoria. Some of the matrix was extracted from inside the specimen and sent to Mr. A. C. Collins for foraminiferal examination. He did not find many foraminifera, and most of them were juvenile rotaliids, but one referrable to *Parrellina verriculata* was found, and this species ranges from the Miocene of Muddy Creek near Hamilton to the present day waters of Bass Strait. The species is not known to occur at Table Cape, nor has anyone definitely found *Tylospira* in rocks older than Upper Miocene.

Tylospira clathrata is a second fossil species of this genus that was also described by Professor Tate. This species has been recorded from many localities, but Mr. R. W. T. Wilkins, after a careful study of the matter, states that it is to be found only at Rosehill farm on the Mitchell River, Gippsland, and its stratigraphical equivalents. This statement has been checked by the collections in the National Museum of Victoria and found to be correct. Mr. Wilkins has recently shown that the beds at Rosehill farm are slightly older than Cheltenhamian. Thus the occurrences of *T. coronata* and *T. clathrata* are mutually exclusive. *T. clathrata* is only reported from the one locality, and it is older than all the proved occurrences of *coronata*. It is very helpful for stratigraphic purposes to have all these occurrences clarified.

The three species of *Tylospira* mentioned so far *(scutulata, coronata, clathrata)* all belong to the subgenus *T.* (*Tylospira*). to the second subgenus *T. (Singletonaria)* belongs *T.* (*Singletonaria*) *lirata* (Marwick, 1952), which is known only from the Upper Miocene (Cheltenhamian) of the Lakes Entrance district of Victoria.

STRANGE SHELL FROM FLINDERS ISLAND

When the soil survey of Flinders Island in Bass Strait was being carried out, Mr. G. M. Dimmock collected a number of fossil shells and sent them to the author for identification. Among these was a strange shell that looked like *Singletonaria* but had a *Tylospira* callus. This shell was sent to Dr. J. Marwick, who decided that as this new species fits in between *Singletonaria* and *Tylospira*, it would be better to reduce his genus *Singletonaria* to a subgenus, and called the new shell *Tylospira (Singletonaria) gilli* (Marwick, 1952, 1960). Its age is probably Middle Pliocene (Gill, 1962).

Thus the history of *Tylospira* can now be traced in the rocks of Australia as follows:

Period	Subgenus *Tylospira*	Subgenus *Singletonaria*
Quaternary	*scutulata*	extinct
Pliocene	*coronata*	*gilli*
Miocene	*coronata*	*lirata*
	clathrata	

ECOLOGY OF *TYLOSPIRA*

Tylospira is a warm temperate mollusc, and is not found alive in Victoria at present, but in the past it thrived as far south as Flinders Island in Tasmania. There is evidence that the climate in S.-E. Australia was then warmer (Parr 1939, Gill 1961) than at present. Text-figure 1 shows this change of latitude with time, and the known distribution of all the described species of *Tylospira*. This genus has ecological limitations in addition to temperature, as is shown by the fact that large numbers are present at a given locality, but as the fossil bed containing them is traced across country the *Tylospira* species disappears. There is much to be learnt yet about the ecology of both the living and fossil species of *Tylospira*.

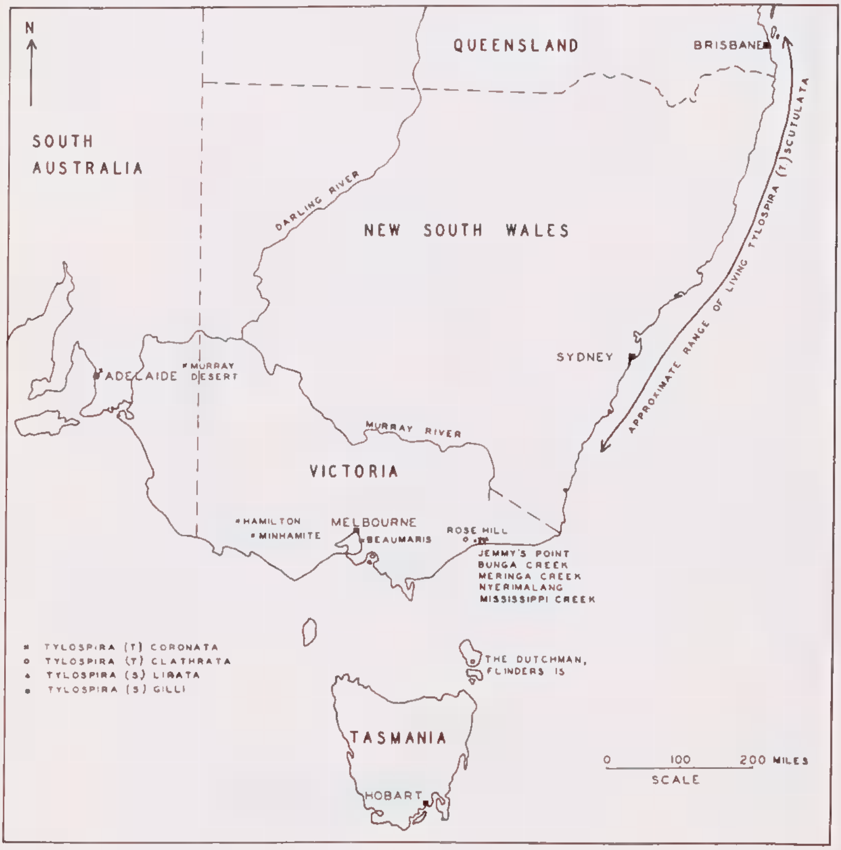

Figure 1.

REFERENCES.

ALLAN, Joyce, 1950. Australian shells. 8 vo. Melbourne

DENNANT, J. and KITSON, A. E., 1903. Catalogue of the described species of fossils (except Bryozoa and Foraminifera) in the Cainozoic fauna of Victoria, S.A. and Tasmania. *Rec. Geol. Surv. Vict.* 1 (2): 89-147.

GILL, E. D. 1957 The stratigraphical occurrence and palaeoecology of some Australian Tertiary marsupials. *Mem. Nat. Mus. Vict.* 21: 135-203.

————, 1961. Cainozoic chapter in *Descriptive Palaeoevology,* London and New York.

————, 1962. Cainozoic chapter in *The Geology of Tasmania.* Geol. Soc. Austr. (in press).

HARRIS, G., 1897, *Cat. Tert. Moll., Brit. Mus.,* Pt. 1.

MARWICK, J., 1950. Notes on the southern family Struthiolariidae. *J. Conchyl.* XC: 234-239.

————, 1952. *Singletonaria,* a new genus of the Struthiolariidae form the Australian Pliocene. *Proc. Malac. Soc. Lond.* 29: 83-85.

————, 1960. A new Pliocene struthiolariid (Gasteropoda) from Flinders Island, Tasmania. *Proc. Roy. Soc. Vict.* 72: 41-44.

PARR, W. J., 1939. Foraminifera of the Pliocene of South-Eastern Australia. *Min. & Geol. Journ.* 1 (4): 65-71.

TATE, R., 1888. The gastropods of the older Tertiary of Australia, Pt. 2. *Trans. Roy. Soc. S.A.* 10: 116-174.

AN OUTLINE OF THE DEVELOPMENT OF THE BIVALVE GASTROPOD *MIDORIGAI AUSTRALIS* BURN, 1960

By B. WISELY, M.Sc.*

Figure 1.

Summary: Specimens of *Midorigai australis* collected in Port Hacking, Sydney, and measuring less than 1.0 mm. in shell length laid two egg masses in the laboratory. Each egg mass contained 50 $\pm$ 2 eggs which developed along typically gastropod lines to hatch on the 11-13th day. Paired statocysts, eyespots, and velar lobes were readily visible in the free swimming veliger. An operculum was present. The protoconch measured 116-118μ in diameter and was brownish and transparent, except for the straight, posterior edge of the opening. The latter was dark brown. Evidently the development of the paired valves and associated musculature takes place later in the life history.

* Division of Fisheries and Oceanography, C.S.I.R.O., Cronulla, N.S.W.

Account: During April, 1962, plankton tows were made through strapweed beds (*Posidonia* sp.) in Port Hacking. Two specimens of a bivalve gastropod were taken in one tow made on the bottom of the channel immediately north of the "Ballast Heap" on April 17. These specimens were set aside in a small dish of seawater containing a few strands of the green alga *Enteromorpha intestinalis.* During the next 24 hours one of them laid an egg mass. Three more slightly smaller specimens were collected at the same locality on April 18, and added to the dish. A second egg mass was found in it on April 24. This showed that some of the specimens were mature, even though the largest present was only 0.98 mm. in shell length. These specimens were sent, together with several others taken in Gunnamatta Bay, Port Hacking, to Mr. R. Burn for identification. Mr. Burn (pers. comm.) has provisionally identified the material as *Midorigai australis* Burn (1960), and is including descriptions of it in his current review of the Australian bivalve gastropods. Since the egg masses were viable, it was possible to make observations on their development. However, because of the risk of heat damage from the microscope lamp such observations were made only for brief, well-spaced intervals; and only an outline of the development was obtained.

The egg masses (fig. 1) contained 50 $\pm$ 2 eggs and were flattened, roughly circular, and 0.5-0.6 mm. in diameter. The eggs (fig. 2) were *c.* 54μ in diameter and white with a clear nuclear zone; each was contained in a tough, transparent, roughly spherical capsule. They had been laid on the *Enteromorpha* and adhered to it firmly. The first egg mass found had evidently been laid only recently because cleavage had not commenced, and the largest bivalve gastropod present (shell length 0.98 mm.) was crawling over its surface. It continued to do this for a further 15 minutes before crawling away. At room temperature (21°C) nearly half the eggs were at the two-cell stage (fig. 3) six hours later. By eight hours all stages up to and including the four-cell were present, but polar bodies were not observed. Several eggs were in the three-cell stage (fig. 4) but polar lobe formation or the transition to the four-cell stage (fig. 5) was not seen. After 24 hours most of the eggs had reached early blastula stages (figs. 6, 7) and by 70 hours rudimentary velar lobes were developing and the embryos were revolving within the egg capsules (fig. 8). During the next three days the velar lobes differentiated and their cilia became more numerous. On the seventh day the larvae were clearly young gastropods. Two black eyespots and two statocysts had appeared (fig. 9) and pigmented areas were present around the circumference of the larvae (fig. 10). This was followed by the appearance of the protoconch and operculum on the ninth and tenth day, but other details were obscured by a growth of algal filaments around the egg mass. The egg capsules within the egg mass now broke down and for a time the veligers swam freely within the large central cavity so formed. Hatching, which took place on the thirteenth day, was delayed by the algal filaments binding the periphery of the egg mass. The second egg mass was not found until its eggs were at the blastula stage; its development was similar, but the algal growth around it was not so well-developed and hatching commenced on the eleventh day.

In the veliger about to hatch (figs. 11, 12) the protoconch was shiny, transparent and brown. It was not a regular spiral but was longest in a plane passing through the dorsal edge of the opening, across the posterior

edge of the latter, to the opposite side of the shell. Its diameter in this plane was 116-118μ. An operculum was present. The posterior edge of the protoconch opening stood out as a dark brown bar and the paired eyespots and statocysts were readily visible. Three lobes in the body were present in the positions shown, but further details were not seen as the veligers would not emerge when illuminated. The newly-hatched veligers were rapid swimmers and the majority of them soon swam into the surface film of the sea-water, to which they adhered. The attraction between the surface film and the apparently hydrophobic protoconch was too powerful for them to break by the action of their cilia and eventually nearly all of them became caught in the surface film and died.

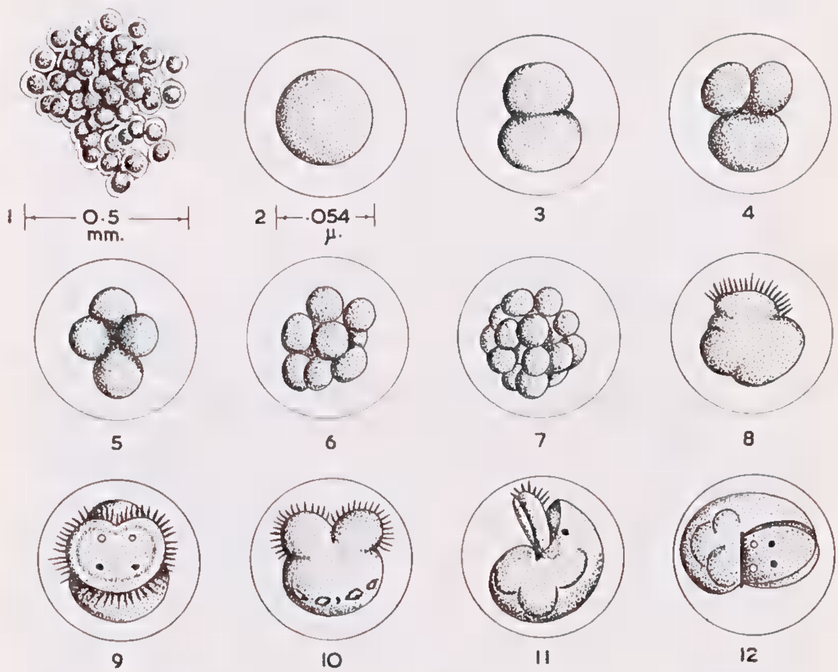

Figure 1.

Stages in the development of *Midorigai australis*.

(1) egg mass; (2) egg in capsule; (3) two-cell stage; (4) three-cell stage; (5) four-cell stage; (6) and (7) early blastulae; (8) early embryo developing velar lobes; (9) and (10) late embryo with statocysts, eyespots and pigmented areas developed; (11) and (12) veliger just before hatching with operculum and protoconch present.

TWO NEW CONE SHELLS (MOLLUSCA, CONIDAE) FROM QUEENSLAND

By J. A. MARSH.*

Plate 4.

Two interesting new species of *Conus* have recently been dredged from waters off the Queensland coast, one from near Townsville by Mr. T. Nielsen of the trawler "Tamoi" and one from Moreton Bay, by the trawler "Challenge".

FAMILY CONIDAE

Genus *CONUS* Linne, 1758.

Syst. Nat. pp. 712-758. Type species by subsequent designation (Children, 1823, Quart. J. Sci., p. 69) *marmoreus* Linne.

Subgenus *LEPTOCONUS* Swainson, 1840.

Treat. Mal. p. 312. Type species by subsequent designation (Herrmannsen, 1847, Ind. Gen. Malac., 1, p. 584) *Conus amadis* Gmelin.

Conus (Leptoconus) nielsenae sp. nov.
(Pl. 4, figs. 1, 2).

Remarks: This interesting species was dredged in 17 fathoms in waters east of Townsville, north Queensland. In appearance it bears a superficial likeness to the fossil *Conus dennanti* Tate. However, the protoconch of the fossil is papillate and knob-like, while this species has the concavely-elevated, sharp-pointed spire typical of *Leptoconus.* The species closest to it in the genus is *Conus monile* Bruguière. *Conus nielsenae* differs from *Conus monile* in having a wider shoulder, more waisted body whorl and relatively unmarked unicoloured appearance. Eight specimens in all were obtained, all of which show little or no variation in size or form from the holotype. Apart from the types, specimens are in the collections of Mrs. J. Grigg, Point Vernon, Mr. G. Alke, Toowoomba, and Mr. R. Brown of Yeppoon, and one specimen is in the author's collection. This species is named in honour of Mollie Nielsen, wife of the finder.

Description: Shell with concavely-elevated, sharp-pointed spire, shoulder angle sharp and wide; sides straight, slightly waisted; smooth polished surface with four lightly incised lines near the base; colour on the body whorl uniformly flesh coloured, encircled with rows of closely set, though fugitive, self-coloured lines. There are some faint lavender coloured growth lines. The shoulder angle is continuously flecked with faint small brown dots; spire white, uniformly streaked with radiating light brown lines or streaks; interior lavender. Periostracum thin, semi-transparent, encircled with rows of projecting hair-like tufts.

Dimensions: Holotype: length 48 mm., width at shoulder 25 mm., length of aperture 45 mm. Paratype: length 46 mm., width at shoulder 27 mm., length of aperture 44 mm.

* McGregor Street, Rockhampton, Queensland.

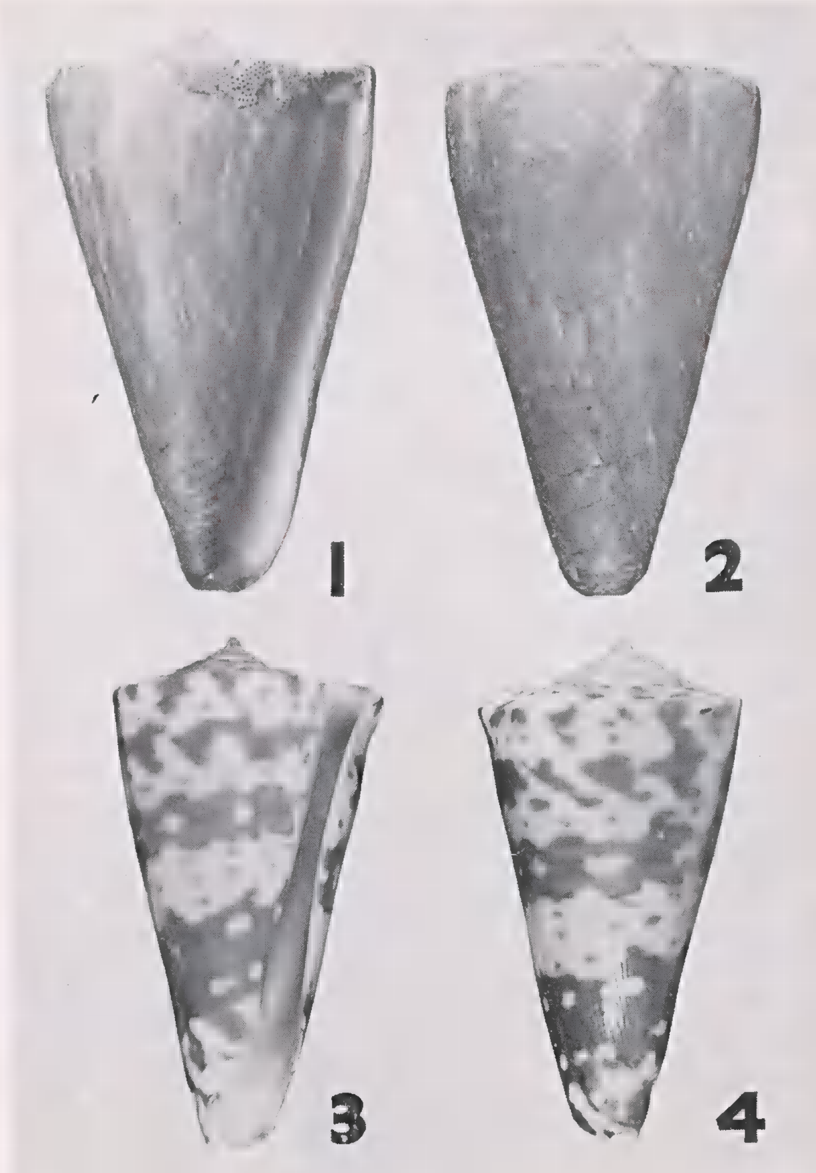

PLATE 4.

Figs. 1, 2: *Conus (Leptoconus) nielsenae* Marsh. Holotype. Australian Museum C. 63707.

Figs. 3, 4: *Conus (Leptoconus) sculletti* Marsh. Holotype. Australian Museum C. 63709.

Type locality: Dredged in 17 fathoms, north-east of Cape Bowling Green, near Townsville, Queensland.

Types: Holotype and paratype (dead specimen) presented to the Australian Museum, Sydney, registered Nos. C. 63707 and C. 63708 respectively.

Conus (Leptoconus) sculletti sp. nov.
(Pl. 4, figs. 3, 4.)

Remarks: This fine species was trawled in 80 to 120 fathoms off Cape Moreton, south Queensland. A consistent variation among specimens examined has been noted. In some specimens the shoulder is wide and the spire concavely-elevated, while specimens which have a narrow shoulder (by comparison) invariably have rather high extruded spires. The nearest species in the genus is *Conus rufimaculosus* Macpherson. The new species differs from *Conus rufimaculosus* in its general dimensions, flaring shoulder angle and slender waisted sides. The species is named in memory of the late Clive Scullett of Port Douglas, a good friend and companion on many reef excursions.

Description: Shell with wide, flaring, sharp shoulder angle, channelled spire with sharp, pointed protoconch; tapering waisted sides; smooth polished surface. Colour greyish white, with a continuous, uneven band of chestnut brown near the base, and two narrower interrupted bands of the same colour higher on the body whorl; between these bands there are some indiscriminate chestnut flecks and streaks; interior flesh-coloured. Periostracum thin, almost obsolete.

Dimensions: Holotype: length 37 mm., width at shoulder 18 mm., length of aperture 34 mm. Paratype: length 35 mm., width at shoulder 15 mm., length of aperture 30 mm.

Type locality: Trawled in 80 to 120 fathoms off Cape Moreton, South Queensland.

Types: Holotype and paratype presented to the Australian Museum, Sydney, registered Nos. C. 63709 and C. 63710 respectively.

Acknowledgements: The assistance of Dr. D. F. McMichael is gratefully acknowledged.

MILTHA IN THE SOUTH-EASTERN AUSTRALIAN TERTIARY

By R. W. T. WILKINS, M.Sc.*

Plate 5, Figure 1.

A recent visit to Flinders Island, Tasmania, and field work in Gippsland, Victoria, has brought to light several specimens of the rare species *Miltha flindersiana* Singleton and Woods, which until the present has been known only from portion of a somewhat worn right valve. Accordingly it is felt that a review of this species is warranted and at the same time the opportunity is taken to introduce some comments on palaeogeography in the Upper Miocene–Lower Pliocene of south-eastern Australia.

FAMILY LUCINIDAE

Genus *MILTHA* H. and A. Adams, 1857.
Miltha flindersiana Singleton and Woods.
(Pl. 5, figs. 1, 2.)

Miltha (Milthoidea) grandis flindersiana. Singleton and Woods, 1934, *Proc. Roy. Soc. Vict.* 46 (2), p. 210, pl. 8, figs. 4a-b.

The new material from Flinders Island which makes it possible to raise the subspecies to a full species consists of the one right and one left valve from the northern end of Nelson Drain (ref. 030614 on Dimmock's soil map, 1957) in the Cameron Inlet Marl. Another specimen was obtained from the lime quarry at the foot of the Dutchman in the Dutchman Coquinoid Limestone (Gill, 1962). Associated faunas indicate that the beds at both localities are approximately equivalent and of Lower Pliocene age though probably somewhat younger than Kalimnan.

There is not much to be added to the description given by Singleton and Woods but it should be noted that the internal ventral margin is not crenulated and that an obsolete anterior tooth is present on the right valve. Internal features can be observed in some detail on P. 22322 (National Museum of Victoria, Melbourne) from the northern end of Nelson Drain. A system of furrows and ridges radiates from beneath the hinge plate; an angular anterior ridge and associated weak furrow joining to just below the dorsal end of the anterior adductor, a more rounded posterior ridge joining to the ventral end of the posterior adductor while an ill-defined furrow passes obliquely across the valve in a slightly sigmoidal line from above the ventral end of the anterior adductor to about the mid-point of the posterior ridge. The posterior ridge is flanked by two shallow furrows which join the median furrow leaving a small ridge between them.

Miltha flindersiana dennanti subsp. nov.
(Pl. 5, figs. 3, 4.)

The holotype consists of an external mould of a left valve (P. 22320, National Museum of Victoria, Melbourne) and the associated steinkern (P. 22321), both in a good state of preservation.

Description of holotype: Shell rather small for the genus, subcircular, compressed, umbonal area missing; lunule small, deeply impressed; surface

* University of Cambridge, England.

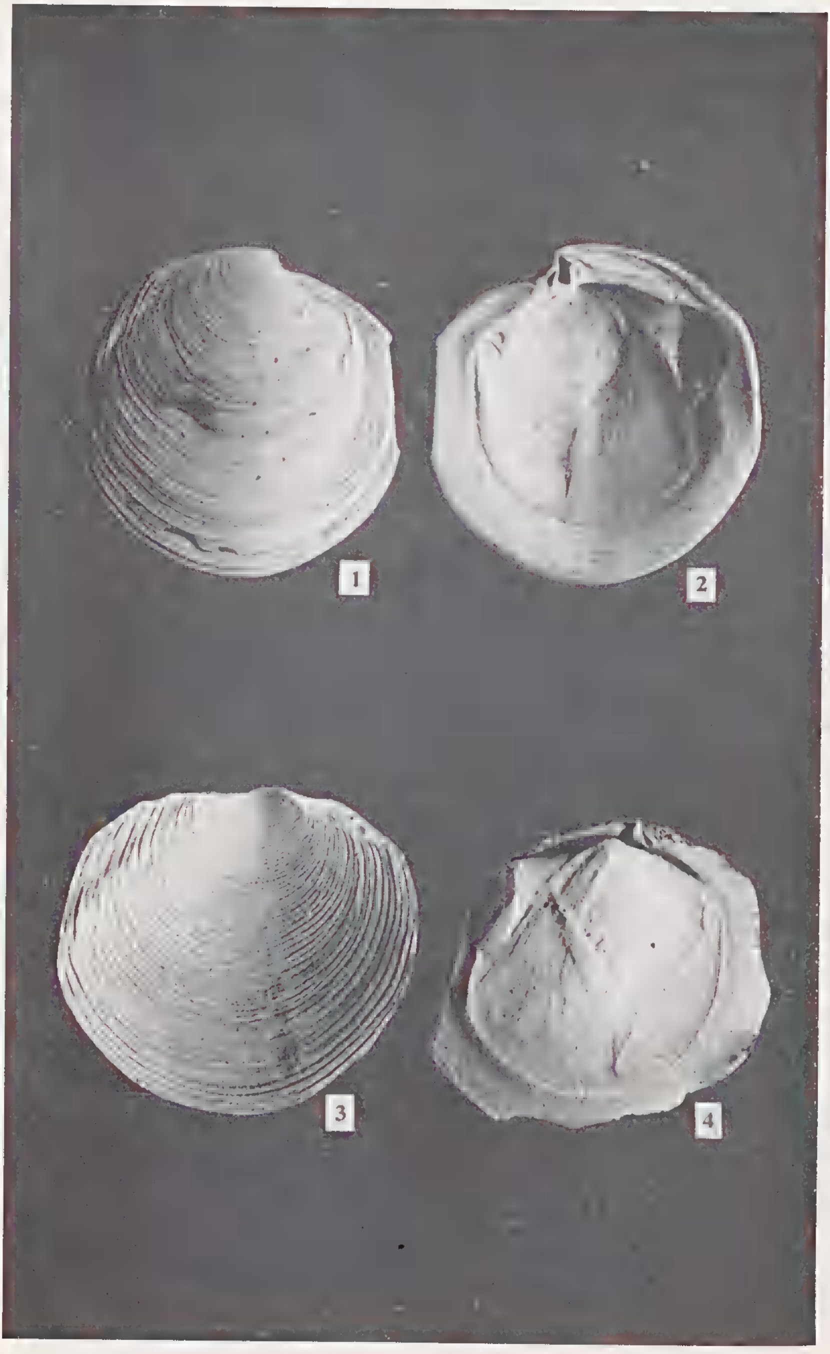

PLATE 5.

sculpture dominantly concentric, of closely and fairly regularly spaced sharp riblets of approximately even development over the whole central area, fine radial markings on ventral portion, irregular and discontinuous, uniting and bifurcating. Slightly anterior to the median position obscure radial lines cross an area of confused concentric riblets. Anterior dorsal area small, well defined, divided by a radial line, concentric lirae; posterior dorsal area large, defined by a prominent radial sulcus, one in two or three of concentric riblets on the body of the shell continuing across this area.

Hinge plate evidently similar to *M. flindersiana flindersiana* but anterior tooth on right valve unusually well developed for the genus. Internal markings also similar, but the two posterior radial furrows better defined and further apart leaving a flattened area between. Medial furrow straight, relatively wide and deep and not sigmoidal as in *M. flindersiana flindersiana.* Interior of left valve similar but with ridge and furrow system not so deeply developed; medial furrow slightly sigmoidal. Muscle scars closely similar in the two subspecies. Interior of valves within the pallial line with radial lines and traces of punctation. Internal margin smooth.

Type locality: "Bellevue", Mitchell River, Victoria (Dennant and Clark, 1903).

Material: Holotype from ferruginous sandstone of the upper quarry, Bellevue section, Mitchell River. Dennant Coll., National Museum of Victoria. Another specimen in the writer's collection is an imperfect cast and mould of a smaller (length *c.* 2.5 cm.) left valve from the same locality.

Age: Associated fauna indicates a Cheltenhamian (U. Miocene) or Kalimnan (L. Pliocene) age (Wilkins, 1963).

Observations: The differences between the subspecies of *M. flindersiana* have been partly indicated in description. In addition the new subspecies has a coarser concentric sculpture, wider posterior dorsal area and a better developed median radial area of sculptural overlap.

Both subspecies are separated from *M. hora* (Cotton) (*nom. nov.* for *Dosinia grandis* N. H. Woods [Ludbrook 1955]), the South Australian fossil species by smaller size, being distinctly less compressed at equivalent size, having better development of the anterior tooth in the right valve and by details of internal ridges and furrows. Although *M. flindersiana*

EXPLANATION OF PLATE 5

Fig. 1: P. 22322. *Miltha flindersiana flindersiana.* Hypotype. Northern end of Nelson Drain, Flinders Is.

Fig. 2: Same specimen as in figure 1. Internal view.

Fig. 3: P. 22320. *Miltha flindersiana dennanti subsp. nov.* Holotype. "Bellevue", near Bairnsdale, Mitchell River, Vict. Internal cast of right valve. External mould in ferruginous sandstone, left valve.

Fig. 4: P. 22321. Same as figure 3. Internal cast of right valve, steinkern in ferruginous sandstone.

All figures 1.5 approximately. Specimens puffed with ammonium chloride before photography.

never has a crenulated internal margin, it is also not invariably present in *M. hora*. Internal thickening and development of hinge features are clearly dependent on size. Comparative measurements are shown in Table 1.

Although *dennanti* is at least externally quite distinct, it is believed that the relationships of the Australian forms are best shown, for the present, by the inclusion of both Victorian and Tasmanian representatives in the same species.

Uncertainty still surrounds *Miltha* from Beaumaris, Victoria. Singleton and Woods (1934) recorded the genus on the basis of an imperfect right valve in the collection of Mr. L. W. Stach but it now appears to be lost (oral communication). A search of the collections of the National Museum of Victoria has yielded one abraded internal cast from the shingle at the base of the cliffs at Beaumaris, the right side of the cast having the characteristic long anterior muscle scar and a pronounced medial furrow joining it to the posterior muscle scar. Another specimen with shelly material badly decomposed and abraded can also be identified by the anterior muscle scar. Neither specimen shows sufficient characters for accurate determination but on the basis of size, which would be about that recorded for *M. flindersiana*, and what can be seen of both internal markings and external sculpture it may be recorded as *M. flindersiana subsp. indet.*

TABLE 1.

Specimen	Length equivalent to height = 30 mm.	Height	Thickness of valve at height = 30 mm.	Valve
P. 22322. Nelson Drain, Flinders Is. Hypotype	30	29	4.8	Right
Dutchman lime quarry, Flinders Is.	30	32	4.9	Right
P. 22320. "Bellevue", Bairnsdale, Vict. Holotype	30	30 est.	5.0	Left
M. 307 Cowandilla Bore, 485′-507′, Adelaide.	31	–	3.2	Left
M. 307 Cowandilla Bore, 485′-507′, Adelaide.	32 est.	81	3.4	Right
M. 305 Cowandilla Bore, 470′-485′, Adelaide.	–	85	3.0	Right
M. 303 Hindmarsh bore, 450′-487′, Adelaide.	32	77	3.5	Right
M. 303 Hindmarsh bore, 450′-487′, Adelaide.	32	65 est.	3.6	Left

All dimensions are in millimetres. Numbers with prefix P. refer to specimens in the collections of the National Museum of Victoria, Melbourne; those with prefix M. refer to specimens in the collection of the South Australian Mines Department.

Singleton and Woods noted that their Beaumaris specimen had a more curved post-umbonal margin than *M. hora* and was less depressed than the Flinders Island shell upon which *flindersiana* was based. According to the data now at hand, which includes five more or less complete valves of *M. hora* from the Dry Creek Sands, kindly forwarded to the writer by Dr. N. H. Ludbrook, neither character can be considered of diagnostic importance on the basis of a single specimen.

Beyond Australia the affinities of the Australian species are with *Miltha neozelanica* Marshall and Murdoch, the type species of the subgenus *Milthoidea* (Marwick, 1931). It is very closely related to the Australian species. More recently Chavan (1938; Ludbrook, 1955) has synonomised *Milthoidea* with *Miltha* but the three species form such a closely related group that some taxonomic designation is perhaps desirable.

DISTRIBUTION OF AUSTRALIAN *MILTHA*.

The recorded occurrences of *Miltha* in south-eastern Australia are shown in text figure 1. The extent of Austral-Indo-Pacific and Bass Strait provinces (Crespin, 1950) in the U. Miocene-L. Pliocene as determined

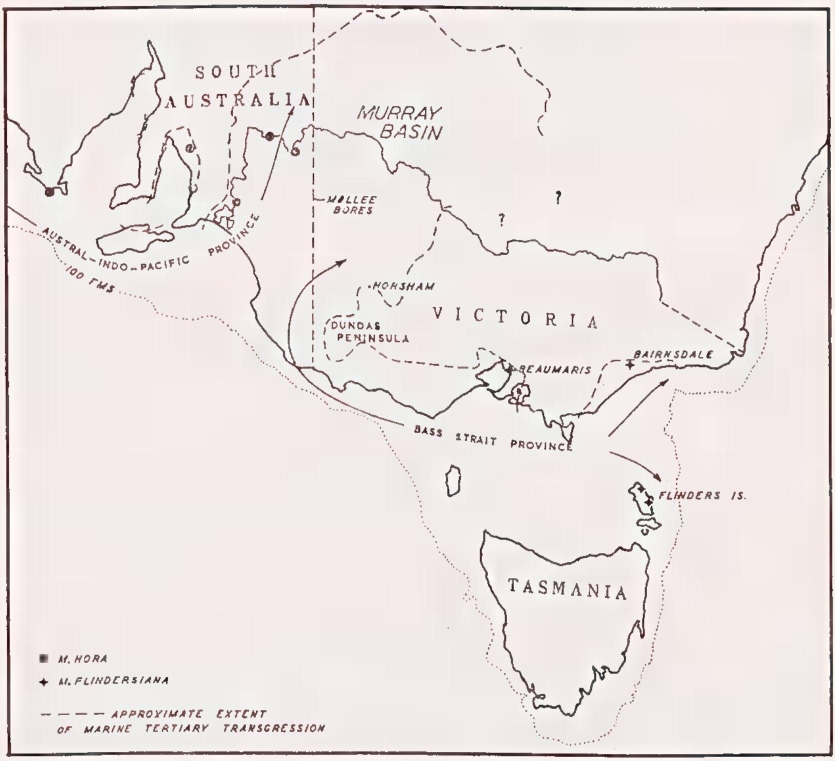

Figure 1.

by molluscan faunas is also shown. It will be observed that each species of *Miltha* is limited to one province. The existence of geographical provinces especially at this horizon where foraminiferal evidence is poor has resulted in considerable difficulty for correlation.

The barrier separating the two provinces is difficult to ascertain. Ludbrook (1954) has criticized the use of the term Bass Strait province suggesting that it is inappropriate mainly because Bass Strait was not in existence at this time. However, the widespread occurrence of Tertiary deposits in the Bass Strait area suggests that this was not so (Gill, 1962).

Appealing to faunal evidence we find that data from Tertiary land faunas is virtually non-existent, but marine molluscan faunas from all Victorian Tertiary basins are sufficiently closely related to make the suggestion of any permanent land barrier between Victoria and Tasmania, from the Oligocene at least, difficult to maintain. Such a barrier would have been a formidable obstacle to the migration of species between the Gippsland Basin in eastern Victoria and the Otway Basin in western Victoria.

Text figure 1 also shows the approximate extent of marine Tertiary transgression in south-eastern Australia. Although this does not necessarily correspond to the extent of Upper Miocene and Lower Pliocene seas it probably indicates the general outline of this portion of the continent at that time. Clearly the Dundas Peninsula was a possible geographical barrier but Pliocene fossils from Horsham (Dennant, 1902) and the Mallee bores (Chapman, 1916) both in the Victorian part of the Murray Basin show relationships with those of the Bass Strait province. The reason for co-existence of faunas belonging to two provinces in the Murray Basin remains unexplained but could be related to actual but unknown land-sea relations in this area. The future discovery of *Miltha* from the critical area can be looked forward to with interest.

ACKNOWLEDGEMENTS:

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REFERENCES.

CHAPMAN, F., 1916. Cainozoic geology of the Mallee and other Victorian bores. *Rec. Geol. Surv. Vict.*, 3: 327-430.

CHAVAN, A., 1938. Essai critique de classification des Lucines. *J. Conch.*, 82: 65-66.

CRESPIN, I., 1950. Australian Tertiary microfaunas and their relationships to assemblages elsewhere in the Pacific Region. *J. Paleont.*, 24 (4): 421-429.

DENNANT, J., 1902. On the occurrence of Miocene strata at Horsham. *Rec. Geol. Surv. Vict.*, 1: 37.

DENNANT, J. and CLARK, D., 1903. Geology of the valley of the lower Mitchell River. *Proc. Roy. Soc. Vict.*, 16: 12-47.

DIMMOCK, G. M., 1957. The soils of Flinders Island, Tasmania. Soils and Land Use Series, No. 23, C.S.I.R.O., Melbourne.

GILL, E. D., 1962. *J. Geol. Soc. Aust.* In press.

LUDBROOK, N. H., 1954. The molluscan fauna of the Pliocene strata underlying the Adelaide Plains. Pt. 1. *Trans. Roy Soc. S.A.*, 77: 42-64.

————, 1955. The molluscan fauna of the Pliocene strata underlying the Adelaide Plains. Pt. 2. *Trans. Roy. Soc. S.A.*, 78: 53-54.

MARWICK, J., 1931. The Tertiary mollusca of the Gisborne district. *N.Z. Geol. Surv. Pal. Bull.*, 13: 70.

SINGLETON, F. A. and WOODS, N. H., 1934. On the occurrence of the Pelecypod genus *Miltha* in the Australian Tertiary. *Proc. Roy. Soc. Vict.*, 46 (2): 207-213.

WILKINS, R. W. T., 1963. The relationships of the Mitchellian, Cheltenhamian and Kalimnan Stages in the Australian Tertiary. *Proc. Roy. Soc. Vict.* In press.

NOTES ON THE SPAWN AND EARLY LIFE HISTORY OF TWO SPECIES OF *CONUBER* FINLAY & MARWICK, 1937 (NATICIDAE).

By FLORENCE V. MURRAY, M.Sc.*

Plates 6-9.

ABSTRACT.

C. conicum and *C. sordidum* differ from other naticids whose breeding is known, in spawning gelatinous egg masses rather than sand-encrusted egg collars. The larvae of both species hatch as free-swimming planktotrophic veligers.

Genus *CONUBER* Finlay & Marwick, 1937, Palaeont. Bull. *N.Z.* 15: 53.

Natica conica Lamarck, 1822, Anim. s. Vert., 6, (2): 198.

Natica sordida Swainson, 1821, Zool. Illustr., 1: pl. 79.
= *Natica plumbea* Lamarck, 1822, Anim. s. Vert., 6, (2): 198.
= *Natica strangei* Reeve, 1855, Conch. Icon., 9, *Natica* pl. 18, fig. 81.

INTRODUCTION.

The existence of an atypical naticid spawn had remained unrecognised until February, 1962, when the specimen (Nat. Mus. Vict., No. F. 22726) of the Conical Sand Snail, *Conuber conicum* (Lamarck, 1822), which had been isolated in a small home aquarium produced a large gelatinous

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egg mass (Murray, 1962) consistent with the "Sausage-blubber" illustrated by Dakin (1952, Pl. 54) and described by him as a gastropod egg mass of unknown parentage. Investigations then revealed that the Sordid Sand Snail, *Conuber sordidum* (Swainson, 1821) produces a similar spawn.†

These observations were subsequently confirmed by Miss J. H. Macpherson, Curator of Molluscs at the National Museum of Victoria in Melbourne, and by Dr. R. J. MacIntyre of the C.S.I.R.O. Division of Fisheries and Oceanography at Cronulla, N.S.W., both of whom isolated the species concerned in laboratory aquaria where identical gelatinous egg masses were spawned.

As it has hitherto been believed that all species of Naticidae embed their egg capsules in a gelatinous matrix impregnated with sand in the form of a "characteristic" spiral sandy ribbon or egg collar, it comes as a surprise to find that some members of the family spawn egg masses of this sausage-blubber type.

Such egg masses are found stranded on sand and seaweed at low tide or floating in ebbing water: they are common objects on the seashores around Australia embracing latitudes of approximately 15°–45°S. and longitudes of approximately 115°–155°E.

C. conicum ranges from south-west Australia, through southern Australia, Tasmania, New South Wales and Queensland: it is common on sandy flats, but is also found in sandy mud areas. *C. sordidum* has much the same range, but does not extend to Tasmania: it inhabits sandy mud tidal flats and estuarine areas.

BREEDING HABITS.

The females of both species are, on the average, slightly larger than the males, as in most prosobranchs, but the shells display little evidence of sex dimorphism.

The breeding season in Victorian waters is about the same for both species—from spring to autumn—although isolated egg masses of *C. conicum* have been collected as late as June, and *C. sordidum* tank-spawned in July at a temperature of 19°C. Fluctuation in the numbers observed of *C. conicum* masses in Port Phillip Bay might well indicate some lunar influence, e.g., they were in abundance during Easter (April 21-22, 1962) but sparse before and after that time. Periods of prolific spawning by *C. sordidum* at Mallacoota Inlet in eastern Victoria, have been noted by Mr. F. Buckland, an experienced member of the fishing industry, who has at times had fishing nets completely fouled with their large gelatinous spawns.

Mating has not been observed, but at least in *C. conicum* it must considerably precede the spawning process, the female having the capacity to store spermatozoa. This was evidenced by *C. conicum* (No. F. 22726) which had been isolated for a month before spawning, then within ten days produced three egg masses measuring 8, 5 and 3 cm. respectively across the outer diameter. The eggs in all three masses were fertile. This

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† Since these notes were prepared, Mr. B. Wisely of the C.S.I.R.O. Division of Fisheries and Oceanography has sent me a gelatinous egg mass of the same type spawned by *Conuber melastoma* (Swainson, 1822): it will be reported upon at a later date.

snail was large, measuring 42 x 28 mm.; a very much smaller specimen, only 20 x 14 mm. spawned a scarcely-curved mass 3.5 cm. long, possibly indicating that this species breeds in its first year. Thus either large or small snails may be responsible for the small egg masses found in the field.

The stages of growth leading to the adult of *C. sordidum* appear to take place mainly in intertidal areas judging from the abundance of juveniles of all ages on the sandy mud beaches at low tide in Western Port localities during summer and autumn. What happens in the case of *C. conicum* is not clear. At no time have small juveniles been seen on the sand flats at Rosebud, in Port Phillip Bay, where large adults are plentiful most of the year and egg masses present throughout the breeding season; but they are to be found at extreme low tide on the sheltered ocean beach in the San Remo channel.

THE SPAWN

(Plate 6.)

In general the egg mass of each species is an incomplete annulus formed by a thick, spiral gelatinous band standing on edge; it varies in length, height (width) and thickness. The outer wall between the basal and apical margins is convex while the inner wall bears the impression of the part of the shell and foot of the animal over which it was formed.

In view of the general similarity in form between these gelatinous spawns and the more typical sand-collars of other naticids, it seems desirable to replace the colloquial term "sausage-blubber" by the more accurate designation "gelatinous egg collar" in describing these egg masses.

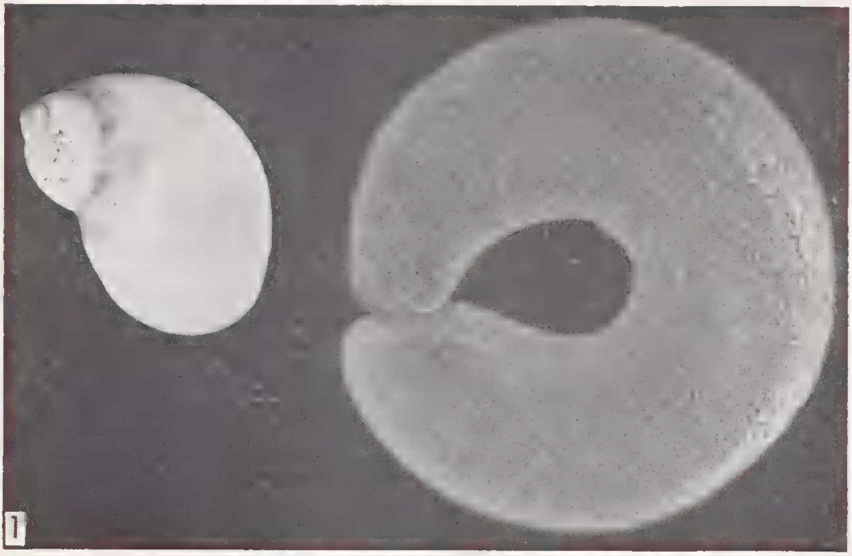
A gelatinous egg collar is composed of a clear, solid jelly diffused with egg capsules and invested with a thin, closely adhering, tough, transparent integument in which there is an overlapping seam along the inside wall extending to the base of the vertical margins.

When hatching begins the integument sloughs off and the jelly slowly dissolves away. The first egg mass spawned by *C. conicum* (No. F. 22726) weighed five ounces and completely dissolved in four days after the first veligers emerged, at a water temperature averaging 25°C. At lower temperatures dissolution takes considerably longer.

It seems remarkable that such small molluscs can suddenly create such massive spawn, but as might be expected, the jelly is mostly sea-water, only a very small amount of organic matter being produced by the animal. An analysis made by the State Laboratories in Melbourne showed the jelly of *C. sordidum* to consist of 96.3% water and 3.7% solids including 3% chlorides expressed as common salt (NaCl).

In general the gelatinous egg collar spawned by *C. sordidum* is larger than that spawned by *C. conicum*, but in each case there is a considerable range in size as indicated by the following measurements taken from field material:

		Outer diameter	Length (Basal Margin)	Weight
C. sordidum	Maximum	10 cm.	27 cm.	7.5 oz.
	Minimum	5 cm.	12 cm.	1.5 oz.
C. conicum	Maximum	9 cm.	25 cm.	5.5 oz.
	Minimum	2 cm.	4 cm.	0.3 oz.



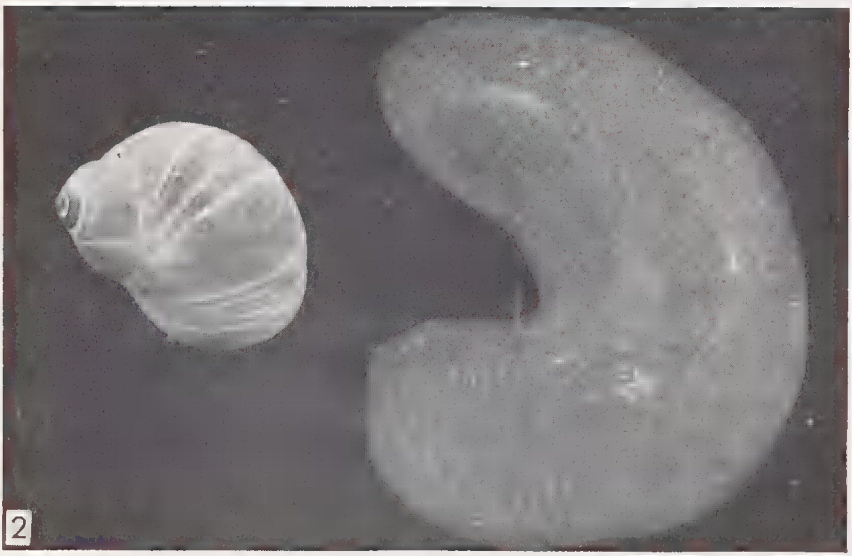


PLATE 6.

Fig. 1: *Conuber conicum* (Lamarck). Shell: 42 x 30 x 23 mm. Spawn: diameter 72 mm.

Fig. 2: *Conuber sordidum* (Swainson). Shell: 41 x 35 x 28 mm. Spawn: diameter 85 mm.

METHODS.

Egg masses were maintained in a small temperature-controlled tank of sea-water with constant aeration. They were removed at regular intervals for examination, without interference, through a stereoscopic microscope, the transparency of the jelly allowing the developing embryos to be seen clearly. Thin sections of jelly, and egg capsules individually dissected from the mass were also used. Photomicrographs proved helpful in checking measurements and some morphological details. Veligers were maintained in small jars of sea-water at room temperature; they were pipetted into fresh sea-water every 24 hours.

THE EGGS
(Plates 7 and 8.)

The distribution of the egg capsules in the egg mass of each species is similar. They are aggregated mainly at the periphery and are sparse toward the interior. Those of *C. sordidum* are larger and more widely spaced than those of *C. conicum*.

In each species the egg is cream-coloured, spherical and covered by a vitelline membrane; it lies within a spherical, elastic envelope with a covering of fine concentrically arranged membranes. The whole is suspended in a clear, viscous material containing fine eccentrically arranged membranes and separated from the jelly of the mass by a thin, transparent pellicle forming an outer spherical capsule of constant size. Two eggs are sometimes found within one capsule, and on occasions three or more may be seen together, each developing normally The outer capsule of *C. sordidum* eggs is visible under the usual magnifications of stereomicroscopy, but that of *C. conicum* is only detectable at high magnifications or by use of special methods.

The egg envelope begins to expand with the onset of cleavage; it doubles in diameter during development and so nearly fills the outer capsule before finally breaking down to liberate the veliger. As the size of the envelope increases the viscous contents of the outer capsule progressively diminish.

The eggs of the two species may be distinguished by the following average diameter dimensions:

	Unsegmented egg	Outer capsule	Envelope (Trochophore)	Envelope (Mature veliger)
C. sordidum	0.250 mm.	0.625 mm.	0.375 mm.	0.525 mm.
C. conicum	0.125 mm.	0.300 mm.	0.175 mm.	0.275 mm.

These measurements relate to material from southern Victoria: some variations occur in the spawn of *C. sordidum* from eastern Victoria, e.g., the veligers hatch when the envelope is only about 0.45 mm. across and does not fill the outer capsule.

DEVELOPMENT.

The overall rate of development varies with the temperature, but there is always a time lag between the first and last hatchings.

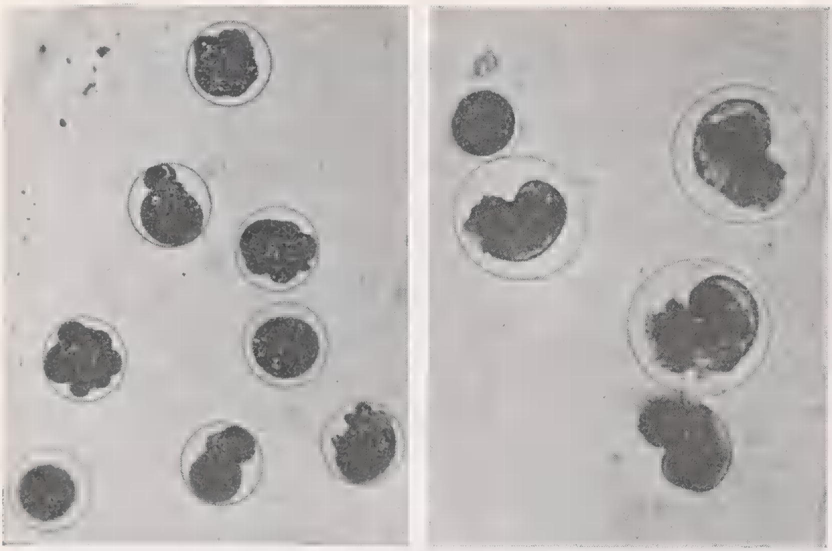


PLATE 7.

C. conicum (Lamarck). Sections of the same egg mass: eggs at various stages of development; envelopes showing progressive expansion. (Outer capsules not apparent). Photomicrographs x 57.

C. sordidum. At a temperature of 20°C the first veligers emerge from an average-sized egg mass in 10 or 11 days and the last in about 18 days. In the following brief outline of development the periods recorded for the various phases relate to the first hatchings only; these vary considerably for subsequent hatchings.

The first two cleavages are almost equal while the third gives rise to four small, transparent micromeres and four large, yolky macromeres. Subsequent cleavages result in the micromeres spreading over the macromeres and a blastula is formed within 12 hours. A flattened gastrula follows which leads to the first larval phase — the trochophore — during the next 36 hours. The various organs of the trochophore then gain in development, and within another 48 hours the second larval phase—the veliger—begins. The outgrowth of the foot and the enlargement of the prototroch as a bilobed velum commences with this 4-day larva or early veliger, which precedes torsion, and the shell, a thin, cuticle-like cap at the posterior end of the body begins to spread. The foot then becomes ciliated and develops paired statocysts and an operculum; two small black eyespots appear on the head from which the yolk now begins to clear. Development continues, and by the seventh day the young veliger is rotating vigorously within its envelope by means of large, strongly-beating cilia which have developed on the lobes of the enlarging velum. By the eighth day most of the yolk has cleared; purplish-black pigment has

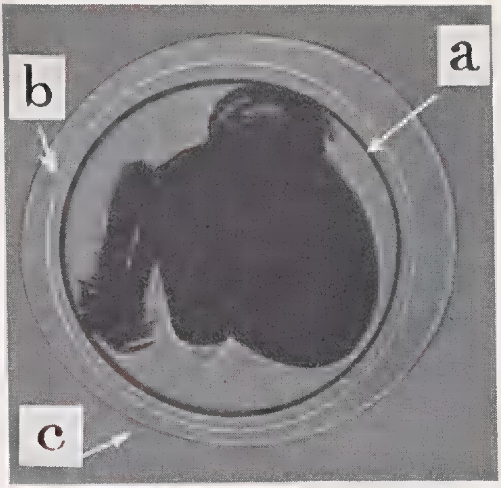


PLATE 8.

C. sordidum (Swainson). Egg capsule containing a young veliger. a = egg envelope, b = outer capsule, c = jelly of the mass. (The fine membranes in the layer surrounding the envelope and in the outer capsule are not apparent).
(x 90) Photomicrograph: slightly retouched.

darkened the visceral coil, oesophagus and intestine; peristalsis is apparent; and the mantle and shell have spread dorsally as far as the position of the larval heart, a transparent sac pulsating strongly. During the succeeding days the lobes of the velum lengthen and acquire a line of purple pigment at the margins; the mantle and shell advance forwards beyond the heart area and a vesicle, probably the early gill anlage, is apparent in the roof of the mantle; the kidney becomes more clearly defined, and the propodium first appears as a small process towards the base of the foot. On the tenth or eleventh day, after some further growth and differentiation, the veliger escapes from the envelope and capsule and works its way through the jelly into the water.

C. conicum. The development of this species follows in general the pattern outlined above for *C. sordidum,* but with some differences. The hatching period is shorter at corresponding temperatures. At 20°C the first veligers emerge in six or seven days; they have a lot of residual yolk and are not as well developed as the first *C. sordidum* veligers to hatch at this temperature. Only a comparatively small amount of pigment is associated with the gut and this appears to be linked in some way with the rate of development. Veligers hatching quickly at 20°C or more, have no pigment, but traces of it appear in those which stay alive for five or six days: it also appears, before hatching, in veligers which develop slowly at low temperatures. The foot does not develop a process-like propodium either before hatching or during the short free-swimming period in culture.

THE VELIGERS

(Plate 9.)

The veligers of both species are planktotrophic and swim about actively, constantly approaching the surface of the water and then turning away. *C. sordidum*, very much the larger of the two, lives for about 16 to 20 days in artificial conditions, but *C. conicum* rarely survives for more than 5 or 6 days.

The external body parts of both veligers are colourless. Each has a bilobed velum, the margin of which has a thick rim edged with large and small cilia, and on the underside another smaller ridge edged with short cilia. Between these two ridges is a finely ciliated groove leading to the mouth. The velum lobes of *C. sordidum* are almost rectangular, average 0.4 mm. in length and have a line of small blocks of purple pigment round the margin; those of *C. conicum* are rounded, average 0.15 mm. in length and have a row of small pigment blocks at the margin. In each, the small black eyespots are well below the base of the very short tentacles; the statocysts, embedded in the base of the foot on either side, are large and spherical and contain a refractile body.

The propodium of *C. sordidum* continues to grow after the veliger hatches and becomes a long flexible process which protrudes between the lobes of the velum when the veliger is swimming and probes about actively over the mouth area. After about 14 to 18 days it seems to shorten and widen a little which may be an early indication of approaching metamorphosis, but at this stage the veliger ceases to swim and lies on the bottom of the dish with its cilia beating only occasionally. It remains thus for a few days, intermittently opening and shutting its operculum and constantly exuding yolk. After final withdrawal into the shell, movements of the mantle and cilia may be seen through the shell until the invasion of scavenging protozoa indicate that life has ceased. Eventually there remains only the shell, operculum, statocysts and a residue of black pigment.

C. conicum veligers after ceasing to swim behave in the same manner.

In both species sinking is probably due to artificial conditions rather than to the approach of metamorphosis as it seems unlikely that this would take place until a more advanced foot structure had been attained. The larva of another naticid, *Glossaulax aulacoglossa* (Pilsbry and Vanatta, 1908) has a flexible process-like propodium which develops into an active part of a functional foot well before the veliger loses its velum and crawls from the capsule.* In view of this, it seems reasonable to assume that the larval propodium of *C. sordidum* would develop in the same way, and the veliger would be capable of crawling before it loses its velum. Presuming this elaboration of the foot to be a prerequisite for metamorphosis, it seems likely that the small *C. conicum* veliger spends a long time in the plankton during which period some propodial development takes place.

C. sordidum veligers from eastern Victorian material begin to hatch in about eight days at 20°C and are smaller and less advanced than those from Western Port. The lobes of the velum are at first oval but soon elongate and become rectangular.

* Paper in manuscript.

PLATE 9.

C. conicum (Lamarck).

Fig. 1: Veliger within the envelope and capsule prior to hatching. The large velar cilia are folded in between the velum lobes. (x 116). Photomicrograph: slightly retouched.

Fig. 2: Hatched veliger, ventral view, showing the large velar cilia. (x 148). Photomicrograph.

THE VELIGER SHELLS

C. sordidum. At hatching the shell averages 0.385 mm. across, but after some periods of growth while the veliger is swimming, it finally averages 0.450 mm. It is translucent and pale horn coloured, later becoming brown-tinged, and consists of about one whorl with a distinct umbilicus and a brown columella. The apex is smooth but the remainder of the whorl is sculptured with fine spiral lines crossed by transverse lines of growth. Specimens have been deposited in the National Museum of Victoria (No. F. 22727).

The larval shells of *C. sordidum* from eastern Victorian material average only 0.375 mm. across after sinking.

C. conicum. Averages 0.188 mm. across at hatching and 0.225 mm. after sinking. It is translucent and pale horn coloured, consists of about one whorl without spiral lines and has an umbilicus and a brown columella (Nat. Mus. Vict., No. F. 22728).

The operculum of each species extends well beyond the foot and is thin and transparent and has the shape and spiral growth typical of the genus.

This study has shown that the two common naticids, *C. conicum* and *C. sordidum* which have a wide geographical distribution, spawn prolifically over a long period. Vast numbers of their pelagic, planktotrophic

veligers with elaborate ciliary feeding mechanisms must surely enter the water, but data concerning their behaviour in off-shore and in-shore waters are needed before attempting an evaluation of their importance as constituents of the plankton.

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REFERENCES.

ALLAN, J., 1959. Australian Shells (Georgian House, Melbourne), p. 134.

ANDERSON, D. T., 1960. The life histories of marine prosobranch gastropods. *J. Malac. Soc. Aust.*, 4: 24.

COTTON, B. C., 1937. Eggs and egg cases of some southern Australian molluscs. *Rec. S. Aust. Mus.*, 6: 102.

DAKIN, W. J., 1952. Australian Seashores (Angus and Robertson, Sydney), p. 259, Pl. 54, 56.

GIGLIOLI, M. E. C., 1955. The egg masses of the Naticidae (Gastropoda). *J. Fish. Res. Bd., Canada*, 12: 287.

LEBOUR, M., 1937. The eggs and larvae of the British Prosobranchs, with special reference to those living in the plankton. *J. Mar. Biol. Ass. U.K.*, 22: 145.

MACPHERSON, J. H. and GABRIEL, C. J., 1962. Marine molluscs of Victoria. (University Press, Melbourne), p. 133.

MURRAY, F. V. 1962. Gelatinous masses spawned by some naticids (Sand-snails). *Aust. J. Sci.*, 25: 62.

RIPPINGALE, O. H. and McMICHAEL, D. F., 1961. Queensland and Great Barrier Reef Shells (Jacaranda, Brisbane), p. 90.

RISBEC, J., 1956. Etude anatomique de Naticidae de Nouvelle-Caledonie. *J. Conchyliol.*, 96: 12.

THORSON, G., 1946. Reproduction and larval development of Danish marine bottom invertebrates. *Medd. Komm. Havundersog., Kbh.* Ser. Plankton, 4: 215.

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